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Technology Review

Edited at the Massachusetts Institute of Technology

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FIRST LINE

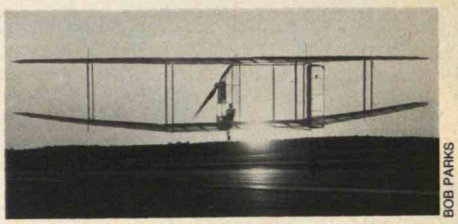
The *Gossamer*'s Grossers

On the theory that her author-husband Morton Grosser has spoken for himself in this issue (*see page 68*) as well as the last, the editors take this opportunity to speak for Janet Grosser, for the *Gossamer Albatross* was clearly a family passion. Indeed, the challenge of human-powered flight was a powerful magnet, and soon after Dr. Grosser joined Paul MacCready's team as its official historian in 1978, Ms. Grosser was commuting to wherever the action was. Ms. Grosser helped build the *Albatross*; she ministered to the wounds of her fellow crew members; she was the only person able to wake pilot Bryan Allen for his predawn flights; and as a member of the landing crew, she was the first person to touch the *Albatross* as it descended onto the sands of Cap Griz-Nez on June 12, 1979. Later, back in California, she was the second woman ever to fly *Gossamer Albatross* (*see the photo below*) and in so doing became the ninth woman ever to fly a human-powered aircraft of any description.

Like her husband, Ms. Grosser has two degrees from M.I.T. (1953 and 1954). She pursued a technical career until the early 1960s, then turned to art and ceramics, and now operates her own calligraphy and typography firm. Though the byline doesn't indicate it, one suspects that *Gossamer Odyssey* has in it some of Janet as well as much of Morton Grosser, for two members of such a partnership are always stronger than one alone.—*J.M.*

MORTON GROSSER

LETTERS



BOB PARKS

Gossamer's Debt to *Chrysalis*

There is more than Morton Grosser tells (*"Building the Gossamer Albatross," April, p. 52*) to the story that the *Gossamer* propeller was the work of three M.I.T. students. For the students (to whom I was a consultant) were themselves engaged in the construction of a pedal-driven airplane called *Chrysalis* (*see above*), with a propeller computer-designed according to my algorithms, based on work of Albert Betz and Ludwig Prandtl at Gottingen in 1919 and verification by Sidney Goldstein in 1929. Computer predictions gave it a cruise efficiency of about 88 percent. Paul MacCready began by negotiating with the students to borrow the *Chrysalis* propeller for the *Gossamer Albatross*, a plan disapproved by the head of the Department of Aeronautics and Astronautics, who feared disruption of the students' own learning experience with *Chrysalis*. Thereupon the three students—Hyong Bang, Robert Parks, and Harold Youngren—stayed up nights to design three new propellers, each at least as efficient as the *Chrysalis* one, for Dr. MacCready. This involved some 150 computer runs, using time donated, as Dr. Grosser noted, by the M.I.T. Student Information Processing Board.

The *Chrysalis* was intended to be a training plane for a future assault on the Kremer Prize. Its 95-pound empty weight and 72-foot span (determined by hangar dimensions) raised its power requirement for level flight with a 160-pound pilot to about 0.4 horsepower, and its strongest pilot, Harold Youngren, never flew it more than five minutes. After June 12, 1979, it became an aeronautical recreation vehicle, and upwards of 40 pilots (including Bryan Allen; Professors Covert, Hollister, Kerrebrock, and David Gordon Wilson; and two women) flew it more than 350 times before it was dismantled forever in September 1979.

E. Eugene Larrabee
Cambridge, Mass.

The writer is associate professor of aeronautics and astronautics at M.I.T.

Furor Over a Non-Vitamin

A-21, it's called. When he first heard about it, Yale's president A. Bartlett Giamatti thought it was a vitamin. It has aroused high ire among scientists and educators, in a ruckus pitting academe against government bureaucracy. The controversy illuminates how Washington's tentacles are spreading on campus, threatening academic freedom and scientific inquiry.

Circular A-21 is a set of regulations issued years ago by the U.S. Office of Management and Budget. It sets forth cost accounting principles for colleges and universities performing research under government grants.

What touched off the current commotion is an amendment to A-21 that took effect last fall over widespread protests. The revision calls for an onerous kind of documentation by faculty members receiving federal research grants. They're now required to account for 100% of their doings. They're supposed to keep track of and report precisely how much time they spend on research, teaching, administration, counseling, and other activities, both on campus and off.

The new tangle of red tape has drawn attack, individually and collectively, from academicians and scientists across the country. They see it as wasteful, meaningless, costly, demeaning, and detrimental to scientific progress. At one large West Coast university, the regulation will generate 3,000 to 8,000 more reports yearly and will mean spending up to $300,000 to put in the new reporting system, according to the journal *Science.*

Among the critics are the National Academy of Sciences, the Association of American Universities, the Council of Scientific Society Presidents, and numerous faculty senates. The academy takes the view that the regulation will churn up a mountain of "cumbersome and meaningless" paperwork, stifle flexibility in research, and frustrate and demoralize faculty members. Educational institutions, already hard pressed financially, will now be forced to spend large sums in ways that contribute nothing to education and science.

Individual professors protest that it's none of the government's business how they spend their time. They seethe at having to tell the government how much effort they devote to activities unrelated to government-sponsored research. The University of Hawaii's faculty senate has decried "any attempt to assess intellectual effort by hours expended, rather than objectives achieved. . ."

A similar reporting requirement was proposed in the late 1960s. It was quickly dropped on recommendation of a government task force that called it "meaningless and a waste of time" both for the government and universities. Now it's back again.

"Never have I seen the lash of federal regulation applied to a crucial area of the nation's intellectual life with such seeming indifference to financial and human consequences," President Giamatti of Yale declared in a speech last fall. "Science is at the core of the university's mission," he said. "Whatever strikes at that core cuts at the heart of the university."

A slowdown in the pace of innovation is a key cause of America's economic sluggishness and declining competitiveness in world markets. Basic research enlarges and builds knowledge leading to technological innovation. Much of America's basic research is carried out in universities. It doesn't make sense to blunt scientific creativity, inquiry, and experimentation on campus through still more layers of red tape that serve only to keep paper-shuffling bureaucrats busy.

Unreasonable View of Renewables

David C. White's view in "Energy Choices for the 1980s" (*August/September, p. 30*) that nuclear reactors are the "most cost-effective way to produce electricity today" would be hard to justify if federal subsidies, tax incentives, and adequate measures for plant decommissioning and waste-fuel disposal were taken into account. Professor Duane Chapman of Cornell University has shown that the actual external and social costs of nuclear generation of electricity are five to ten times the current sales price. Professor White's focus on the traditional "hard path" of energy supply is unfortunate and unreasonable; almost anyone paying more than 4 cents per kilowatt-hour would find solar-heated water cost-effective. I am convinced that we must build for our energy future around the use of renewables and conservation.

Aviv Goldsmith
Little Rock, Ark.

Mr. Goldsmith is a consultant with Community Energy Futures, Inc.—Ed.

I suggest that David White extend his analysis to include products of coal easily derived by pyrolysis, which consumes about 8 to 10 percent of the energy in coal compared with 25 percent for coal gasification and 35 percent for coal liquefaction. Three useful fuels are derived from pyrolysis: gas, to replace natural gas in gas-burning furnaces; liquid, used in oil-burning furnaces; and char, used in furnaces originally designed for coal but that now use oil. Neither the pyrolysis gas nor liquid requires stack-gas cleanup because the fuel itself can be cleaned better and at less cost.

S.A. Guerrieri
Newark, Del.

The Lead Debate Goes On

Dr. Herbert L. Needleman fails to include in "Lead Exposure and Human Health: Recent Data on an Ancient Problem" (*March/April 1980, p. 38*) important details of his study that render his conclusions questionable. In fact, there are methodological flaws with his study just as he believes exist in the studies he criticizes.

Dr. Needleman points out that the level of lead in the blood is only a short-term measure and does not adequately represent a child's past total exposure. He states *a priori* that lead concentration in teeth provides a better measure of past exposure, and then relies upon this measure. But there are insufficient data to show that dentine lead concentration relates to acute lead absorption, and at least one study has failed to find a correlation between dental and blood lead concentration.

After noting that insensitive measures have been used in many studies relating children's lead exposure to behavior, it is surprising to find Dr. Needleman relying on the teacher rating method (an 11-point, forced-choice scale), which appears to have been devised for his study and never adequately evaluated for validity or reliability. On that scale, a teacher's response to a subjective issue such as behavior would be variable and arbitrary.

Dr. Needleman appears concerned that non-lead-related variables relating to child development or behavior have affected the results of some studies. His own study is similarly flawed. Paternal education and socioeconomic status are significantly different between "low-lead" and "high-lead" groups, the fathers of "low-lead" children being better educated and of a higher socioeconomic class. It has clearly been demonstrated in many different contexts that developmental and educational achievement of children is directly related to parental education. Similarly, the Needleman study does not consider iron deficiency, a common childhood nutritional deficit recently shown to affect neuropsychological test scores of young children.

In their studies, Dr. Needleman and his colleagues fail to consider the possibility that the children with high dental lead levels had experiences that rendered them both more likely to ingest environmental lead in their early years and less likely to exhibit favorable behavior and intellectual functions. It has recently been shown that the quality of care giving is likely to be the underlying factor relating directly to both lead exposure and intellectual function.

Edward McCabe
Scrade F. Radtke
New York, N.Y.

(Continued on page 87)

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Kenneth Boulding

Cowboy Economics

JON McINTOSH

As one contemplates the political scene nowadays, it is hard not to get the feeling that one is sitting through a very long and rather bad cowboy movie. The world is divided into good guys and bad guys in the international scene, with the United States, of course, clearly wearing the white hat. In the domestic scene, the private sector is wearing white and the public sector black. To people raised on cowboy movies, this scenario has a certain nostalgic charm. However, one has grave doubts about whether the plot is adequate to deal with international and domestic complexities. It may be that the world's a stage, but the play is by no means simple. In the age of space travel, it is ironic that we have landed ourselves in what future historians may well call the "first cowboy administration."

Horse Power and Cow Supply

I cannot recall ever seeing a treatise on cowboy economics. In the movies, at least, it appears to involve horses, cows, and shootouts. Historically, horses have created chevaliers and caballeros, that is, knights. In most societies, there was not enough hay for everybody to have a horse, so that whoever owned one was in a superior position to anyone who did not. Horses, therefore, tended to produce feudal systems. The brief American cowboy era may have been an exception: because of the low density of the human population, there was enough hay for everybody to have a horse. But even then horses tended to produce bellicosity. Perhaps when males look at the world from an unnatural ten feet up in the air, they get delusions of macho grandeur. It is also hard to be very productive on a horse; we do most of our work on two feet as pedestrians, or in the old days, as peasants. Not surprisingly, then, cowboy economics concentrates heavily on threat systems, threat-counterthreat, being quick on the draw, and thievery when you can get away with it.

Cowboy economics, of course, also depends on cows, curious creatures that have some tendency to become sacred. Cows, especially on the open range, are the perfect, and perhaps the only, example of supply-side economics. All one has to do is leave them alone while they breed and feed themselves, corral them, and drive them to market when the time is ripe. The student of an economist friend of mine once responded to an examination question on marginal productivity: "You have a cow and it has a calf; *that's* marginal productivity!" It is not surprising that cowboy economics believes in the magic of unleashing supply.

Another characteristic of the cowboy economy is that it does not have very much in the way of grants, or one-way transfers, except maybe in the gambling saloon or thievery. Public transfers, certainly, are never heard of. There are remarkably few children, old or indigent people, or women in cowboy movies; apart from the occasional "mush," there didn't even seem to be any sex. Cowboys are obviously cloned straight from the mind of the moviemaker. All is exchange—the tinkle of coins at the bar, bluff transactions at the cattle market.

Another thing lacking in the cowboy economy is conservation. Conservation may be all right for the crowded rice fields, but who needs it in great open spaces? The world is a great ripe fruit waiting to be picked, and never mind who planted it or whether we need to plant another. No cowboy ever felt an urge to recycle the manure, and why should he? It recycles itself.

The Last Shoot-Out

Any resemblance between this fantasy and the present administration may not be wholly accidental. The cowboy is our national hero and the country is in a cowboy mood. Unfortunately, cowboy eras always seem to contain the seeds of their own destruction. The great hunters that invaded North America across the Bering land bridge some 11,000 years ago took a few hundred or maybe a couple of thousand years to kill off all the big game. They ate all the horses without learning how to ride them. There must have been a phenomenal unrecorded collapse between 10,000 and 9,000 B.C.: Mongols on horseback ravaged nearly all of Eurasia for space. Now Mongolia is a minor buffer state, and now barbed wire has closed many of our great open spaces.

Therefore, it could be catastrophic that at the precise moment in history when the cowboy era has reached its end and the cowboy economy has become almost grotesquely inappropriate, we have a cowboy government. The philosophy of the shoot-out threatens to destroy our whole society in a nuclear war, the chances of which have increased quite perceptibly in the last few

months. We live in a world in which the management of conflict has become a major problem, simply because the costs of unmanaged conflict have skyrocketed almost to infinity. Yet we have retreated into a philosophy of winning fights, which is a wholly different skill from managing conflict.

A Riderless Horse

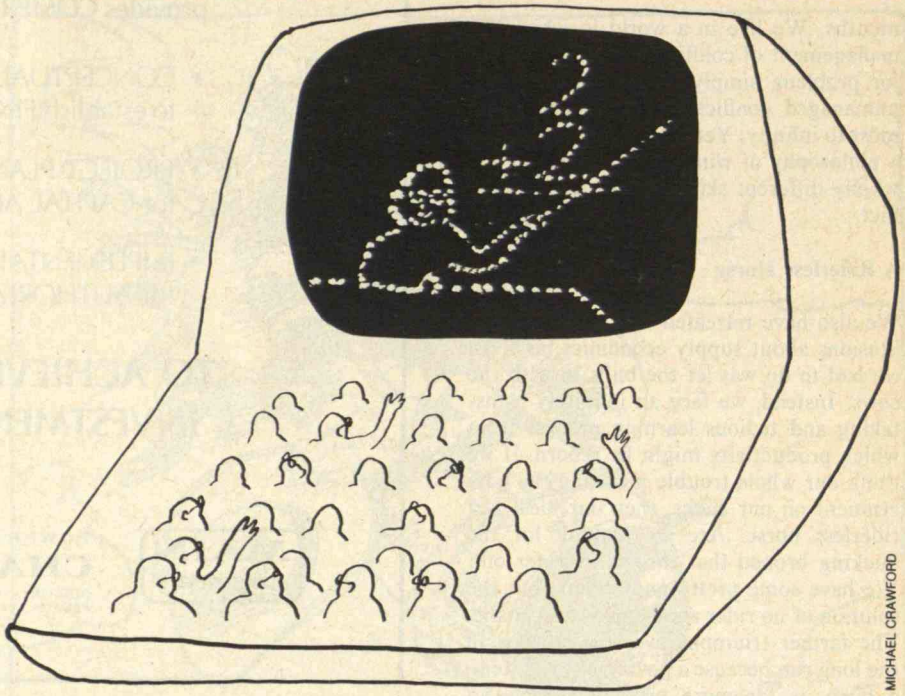
We also have retreated into extraordinary illusions about supply economics, as if all we had to do was let the bulls in with the cows. Instead, we face an infinitely painstaking and tedious learning process from which productivity might be reborn. If we think our whole trouble is having the government on our backs, then our ideal is a riderless horse. Are we looking for the bucking bronco that throws its rider off? We have some pretty poor riders, but the solution of no rider at all seems unrealistic. The farmer triumphs over the cowboy in the long run because a governed ecosystem, a farm, is far more productive than an ungoverned one, a cattle range. The moral would seem to be that a well-governed society is more productive than a not-governed society.

Undoubtedly, the most dangerous aspect of the present situation is the almost universal belief in the capacity of our national defense. The truth is that traditional unilateral national defense can only assure our destruction. The more we put into our defense, the less secure we become and the more we hinder our productivity. The relationship between the proportion of GNP that goes into national defense and the failure of productivity is very clear. National defense is a cancer that eats out the health of the rest of the body politic and virtually guarantees our eventual extinction in nuclear war. Fortunately, there is a substitute: multinational defense based on a positive policy for stable peace. This is a long way from the cowboy economy. One only hopes we will reach it in time. □

Kenneth E. Boulding is a program director at the Institute of Behavorial Science and distinguished professor emeritus of economics at the University of Colorado at Boulder.

Robert Cowen

New Literacy for the Computer Age



MICHAEL CRAWFORD

THE National Council of Teachers of Mathematics (NCTM) has thrown quite a challenge at educators and parents and, by implication, everyone else. Indeed, in a recent position statement, it has called attention to the fact that a new era is upon us.

"Mathematics programs must take full advantage of the power of computers at all grade levels. Students and teachers should obtain a working knowledge of how one interacts with computers and uses their capabilities," the council says. It adds that "computer literacy is an essential outcome of contemporary education. Each student should acquire an understanding of the versatility and limitations of the computer through firsthand experience in a variety of fields." Ditto for the rest of us.

For bemused parents trying to cope with our increasingly complex world, that may sound like a second round of "new math." For teachers struggling to maintain educational quality within tax-revolt budgets, it may sound like an impossibly costly retrofitting of classrooms. But the NCTM is right: the much-prophesized "computer age" has dawned and is already into its early-morning awakening.

Computers, of course, have been with us for decades. But in the 1980s they are going to become more than remote, somewhat mysterious devices that other people use on our behalf; they are literally going to move in with us at home and at work. And probably the largest area of involvement will be in information—its generation, accessibility, dissemination, and use.

Personalized News

With small computers that can communicate with one another and tap large data bases, whether within a single organization or nationally and internationally via phone lines, individuals will have a radically new tool. The social and cultural ramifications can only be dimly foreseen, but at least some trends have begun to emerge. For example, books, newspapers, and magazines may already be obsolete in their present form. One straw in this wind of change is that this column is being written on a home computer. It could theoretically transmit the column directly to any reader similarly equipped with a telephone modem (modulator-demodulator) for sensing and receiving streams of computer data. Or what would sit better with the publisher, all of *Technology Review* could be available in a data base that readers could tap.

A number of newspapers already have regular electronic editions available through networks such as The Source, CompuServ, and the Apple Computer-Dow Jones service. There's a lot of discussion about whether these electronic editions will drive paper newspapers and magazines out of existence. That is doubtful, given the convenience of a product that can be carried about and read anywhere. But the electronic product does give the consumer a new and powerful option to be his or her own editor, as James A. Levin of the University of California has pointed out.

He calls it "interactive news." You can program your computer to monitor and select those stories in which you have a special interest from the flood of materials, including news wire files, now available on the information networks. What is even more intriguing, subscribers to network services can become news sources themselves. These networks now provide bulletin boards, teleconferencing, electronic mail, and other information-transfer services. Dr. Levin explains: "Such dynamic and decentralized information networks redefine the meaning of the word 'news,' shifting from the current institutional definition (reported in newspapers, radio, and television) to a more personal one (that which you find interesting). (*See "Technology and Change in Modern Communications" by Ithiel de Sola Pool, November/December 1980, page 64.*)

Connections

Such computer-based information networks contain the seeds of an information revolution. As these networks grow and become common, local communities will become linked together as they now are by telephone. But unlike the telephone, these local information utilities will have a variety of data banks in addition to communications services with information on how various community problems have been handled. These local networks will interconnect nationally and eventually internationally so that this information will be available on a real-time basis. Communities can share their experiences, call on one another for advice, and exchange solutions to common problems, with the potential for treating a degree of social cohesiveness on a national scale formerly possible only in the village.

This is already happening on a small scale where high school students have access to computer networks. Robert H. Davis of the University of Illinois, a pio-

neer in computer-based education, notes that for such students, "Doing homework is a lot less solitary than it used to be." He explains: "On some time-sharing systems, you aren't just connected to a computer, you're connected to 500 or more other human beings. One of them may know the answer to your question and be willing to take a moment to help you out. Of course, you may be in Urbana, Illinois, and the person who helps you may be in Palo Alto, California."

In many cases, computer-based education means one-to-one interaction of learner and machine. This too has great potential and severe limitations. A wide variety of material can be learned by people working at their own pace. Computer simulations allow exploration of certain subjects that is impossible even with advanced calculators and paper. But there is the danger of gaining only a theoretical knowledge, so that direct experience—of a rain shower, for example—must not be neglected. And some subjects just don't lend themselves to computerized instruction; it would be an ineffective means of learning to ride a bicycle. Thus, Dr. Davis warns, a great deal more thought and experimentation still needs to be done to find the best way to use this powerful new teaching tool.

Hearing Through the Stomach

Nevertheless, and especially for underprivileged and handicapped people, the computer can open new horizons for self-fulfillment and achievement. William C. Norris, chairperson and chief executive officer of Control Data Corp., says that experience with PLATO, his company's widely used computer-based educational system, convinces him that "at some time in the future, the human benefits of the computer will dwarf the economic."

He points out that, among other things, the PLATO keyboard has been modified so that paraplegics can operate it with a mouth paddle or head stick. Suddenly, they have a world of information that they can manipulate and study, to say nothing of a new social life through computer "networking." New opportunities are opened for the deaf by a waist belt, now under development, that transforms the sounds of words and sentences into rippling sensations. Simultaneously, the associated words are displayed by the computer so that the wearer of the belt can learn to "hear" through the stomach.

And, in what Mr. Norris considers a particularly significant development, a PLATO program called HOMEWORK now provides job opportunities such as design and evaluation of educational courses for shut-ins the severely disabled, or people in relatively isolated communities.

Describing applications such as these in the *Christian Science Monitor*, he said that they show that "computer-based education can bring a human touch to learning that most of our schools are failing to impart." He added, "Those who doubt the accuracy of that observation should spend a few minutes watching the huge and beautifully visible satisfaction of a disadvantaged young person's initial experience with a PLATO terminal. They quickly realize that, for the first time in their lives, they are in control of enormous power—a world of knowledge at their command."

Computer-Aided Democratization

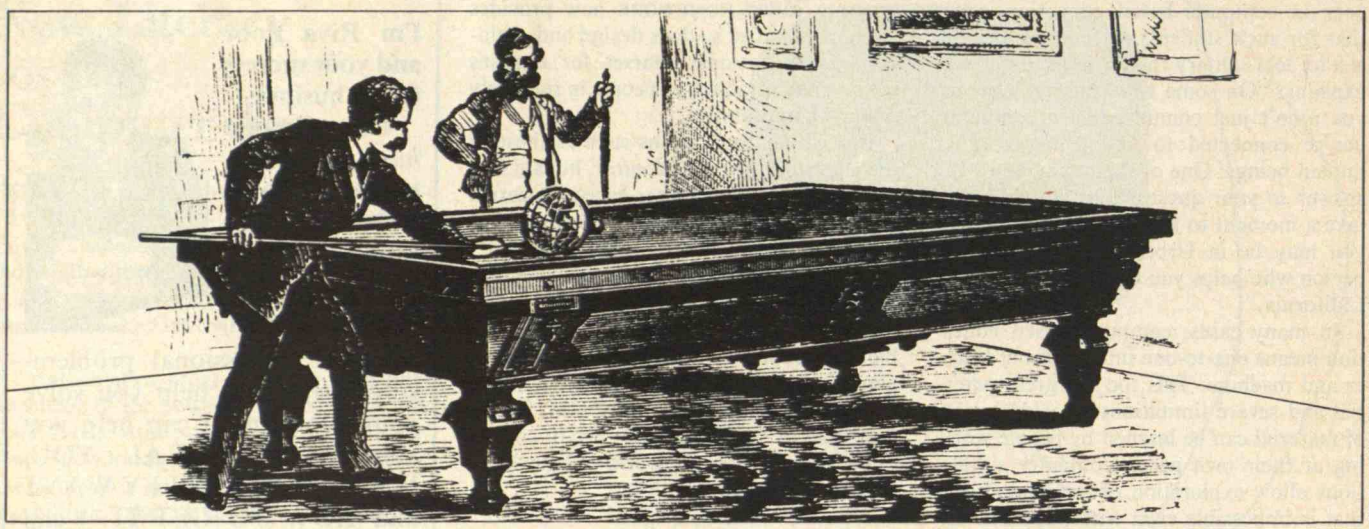
Meanwhile, back at the office, the wide availability of small computers that can tap large data bases and link individuals through information nets promises a new togetherness among far-flung branches of an organization and new ways to handle decision making. Anne Mayfield and Ann Laynor, information systems consultants with Arthur D. Little, Inc., point out that the equipment will be so cheap within a decade that terminals can be made widely available at all levels of an organization. New opportunities for sharing, using, and evaluating information will open up, challenging management "to take advantage of the most precious resource of all: its people. . . . Decision making can be moved to even higher levels within an organization, or it can be pushed down to include many more people."

What actually will happen over the next two decades as personal use of computers diffuses throughout industrialized societies—and to some extent the developing world—is virtually impossible to foretell. But mathematics teachers seem prescient to insist that computer literacy join "the three R's" as an essential basic skill. □

Robert C. Cowen is science editor of the Christian Science Monitor and former president of the National Association of Science Writers. He holds S.B. and S.M. degrees in meteorology from M.I.T.

Why Energy Policies Fail

by A. Mackenzie Thompson



JOE LANDRY AND NANCY LINDGREN

AMERICANS have seen petroleum prices soar through a tenfold increase in eight short years, and direct and indirect consumer expenditures for energy have kept pace, progressively eroding our overall standard of living. Even more striking has been our impotence in dealing with the causes or consequences of this crisis. Many people feel that the underlying causes of the energy crisis are beyond our control—because of the depletion of a nonrenewable resource, or the OPEC cartel, or both. Yet the very interests that paralyze effective remedial measures are largely responsible for the origin and severity of the crisis as well.

Business as Usual

We all know that energy prices are fueling a raging inflation that is predominantly regressive. Poorer people are harder hit not only because they must spend proportionately more of their income on the necessities of heating, transportation, and energy-intensive food and textile products, but also because they must allocate more, and frequently all, of their income to consumption.

The U.S. Department of Energy estimates that poor households in 1980 spend about four times as much of their income on energy alone, while actually consuming less than half as many Btu's, as the average American family. Investigators have also found that at least 35 percent of the typical low-income budget is committed to energy. This situation can only deteriorate further as the cost of essential energy continues to escalate.

We are also witnessing massive disruption and dislocation in the industrial sector. While petroleum producers heralded their best year ever, producers of energy-using commodities such as automobiles reported record losses, throwing hundreds of thousands of workers into the streets. According to the U.S. Bureau of Labor Statistics, unemployment in the auto and steel industries alone has increased by more than 300,000 since 1973, more than one-fifth of these industries' workforce.

The consequences are no less severe in the international arena. While we are enriching the OPEC monarchs and other elites with petro-dollars, we are also aggressively rattling our swords in the Persian Gulf and other oil-rich regions. As the oil import bill rises, we are also apparently willing to invoke tariffs, quotas, and other protectionist policies in the auto and steel industries, possibly igniting trade wars with other industrialized economies.

At the bottom of the international heap and sinking fast are the non-oil-producing Third World nations. With their need for imported energy depressing their terms of trade, these countries can only look forward to decreasing or nonexistent rates of development, greater dependence upon the advanced economies, and increasing vulnerability to further imperialism.

Assuming that energy price rises are inevitable, mainstream policymakers attempt only to accommodate the attendant disruptions. They trot out the genre of tired, worn-out monetary and fiscal policies that have time and again failed to deliver full employment with price stability. We are told that wages must be depressed and energy prices must be elevated, moves that may help to clear markets but can only serve to exacerbate the regressive impact upon real incomes.

Now trendy "supply siders" are advocating various business giveaways to stimulate investment as well. Underscoring the perversity of these policies, we learn that adversely affected corporations are eligible for tariff protection and bail-outs while unemployment benefits are severely curtailed. The promise of a better tomorrow has a particularly hollow ring.

As bankrupt, apologetic, and superficial as these policies are, they contain a kernel of reality. In our economy where the productive wealth is not democratically controlled, private owners must be cajoled and bribed to pursue broad social objectives, even if this entails reducing further the purchasing power and welfare of the wage-earning population.

Reassessing the Crisis

A growing number of analysts have been less eager to accept the immutability of the energy crisis, with good reason. Far from experiencing the ultimate depletion of oil, we are witnessing the consequences of an appropriation of economic and political power heretofore unknown in the corporate world. Nor is this situation unexpected; it is the logical outcome of forces operating for the past half-century or more. Indeed, the principal obstacle to this long-ripening crisis has been the global ubiquity of petroleum reserves. With each new discovery in east Texas, the Mideast, and elsewhere, control of oil by the major producers became more precarious, and these few firms inevitably struggled to reconsolidate hegemony over the resource base.

These few international corporate giants are involved either individually or as a group wherever oil is found outside Sino-Soviet regions, dominating the industry from exploration through development, production, refining, and distribution to retail sale. As impressive as this integration is, it vastly understates the degree of economic and political control these firms exercise. For example, the oil giants have pioneered a number of institutions to promote even greater cooperation and to suppress competition among participants. Included are literally hundreds of domestic and international joint ventures in bidding, production, and transportation as well as interlocking directorate, equity, and liability structures throughout the energy industry. A recent report by the U.S. Senate Committee on Government Affairs documents that Mobil maintains 567 direct and indirect interlocks with other energy boards of directors, while Exxon claims 454, Standard of California 415, Atlantic Richfield 396, and so on.

Even more sobering, state and federal governments have frequently intervened on behalf of these private interests when circumstances such as newly discovered cheap resources threatened to disrupt the carefully orchestrated control. These policies have ranged from state and federal rationing to limit production to import quotas restricting the entry of cheap Mideast oil into U.S. markets. Policies have also included tax bonanzas such as depletion allowances and bogus foreign credits, reducing effective tax rates to as little as 3 percent of actual profits. Thus, Americans have not only paid high premiums at the pump, they have also heavily subsidized the oil industry's tax obligations.

President Reagan's recent speedup of deregulation is a prime example of the interdependency of oil and government. Because new discoveries were already exempt from controls, deregulation provides negligible incentives for domestic expansion of supply while adding billions of dollars to oil company coffers. Most observers acknowledge this action as the oil industry's due for political support, but the currents run deeper. The administration would prefer to feel the inflationary impact of decontrol immediately rather than spread over several months so it can blame early problems on predecessors. Perhaps more importantly, once the price pass-through is complete, the rate of inflation will probably appear to decline. Moreover, given the so-called windfall profits tax, government revenues will be boosted by several billions of dollars in each of the coming years, aiding the pursuit of a balanced federal budget, albeit at the consumer's expense. The coming decontrol of natural gas promises to equal the impact of oil decontrol on company profits and government revenues.

Despite these multilayered machinations of oil firms and their state and federal accomplices, independent oil companies were gaining access to Libyan oil by the late 1960s and threatening to seriously disrupt business as usual for the majors. This process came to an abrupt halt in September 1973, when OPEC moved to restrict production and forced prices rapidly upward. While the oil companies had to cut OPEC in on the resulting largess, the majors have made out handsomely. According to the Chase Manhattan Bank, profits of the majors exceeded $18 billion in 1979, nearly six times their 1972 earnings. This trend continued in 1980, with Mobil reporting a whopping 63 percent increase in net income over 1979 and the other majors reporting similar advances. Fully one-third of all U.S. corporate profits accrued to oil last year.

These impressive figures are dwarfed by the more than $2-trillion "windfall" these firms expect to garner from domestic oil and gas production alone in the coming decade, but only if OPEC is able to maintain prices. OPEC in turn depends heavily upon the major petroleum producers for the crucial technology for production as well as an appropriate network for distribution and marketing. Thus, we can scarcely expect the majors to effect an aggressive stance toward OPEC and risk killing the goose that lays the golden eggs. Both partners can be expected to support their symbiotic relationship without which both would likely fail.

Lateral Moves

What will the oil industry do with these fantastic sums? One direction is clear: it will continue to expand its interests in the nonpetroleum energy industries. Oil companies now account for over one-third of U.S. coal production and control nearly one-half the nation's privately held coal reserves, with attention focused most heavily on the rich western deposits. Standard of California is currently putting together the grandest merger in corporate history, offering $4 billion for AMAX, the nation's third largest coal producer. Oil concerns also account for about 70 percent of uranium production and reserves and are among the most active participants in the development of synthetic fuels from oil shale and coal. Many oil companies are also dabbling in solar and wind technologies.

These lateral moves will not assuage current shortages. The oil concerns understand that for their control of oil to pay off, they must also control actual and potential alternative energy resources. Their huge surpluses are not used principally for the development and expansion of alternative fuel but for the acquisition of existing capacity. In an industry that cries out for innovative solutions to difficult problems, the major oil firms devote less than one-third as much of their revenues to research and development as the average U.S. corporation. If these tendencies continue unabated, we will be confronted by the same corporate entities in all energy markets, and we can expect the same treatment we have received during the past seven years.

Instead of acquiescing to this exercise of power by and for special interests, we need to vigorously address effective remedies. Theoretically, the existing policy tools of regulation and antitrust measures offer a means for curbing some of the abuses. However, the historical record does not hold out much hope: special interests have successfully used their economic and political power to subvert the good intentions of concerned policymakers and enlisted government support for private objectives.

If these economic forces are to be applied to the commonweal, we need to terminate control of energy by sectarian interests. The American people can no longer afford the luxury of entrusting essential national resources to the vagaries of private dominion. We must ultimately assert full democratic control over these crucial resources; to do any less is to accept further social deterioration. □

A. MacKenzie Thompson is assistant professor of economics at Vassar College. He received his Ph.D. from Stanford University and is the author of The U.S. Coal Industry *(Garland Press, 1980).*

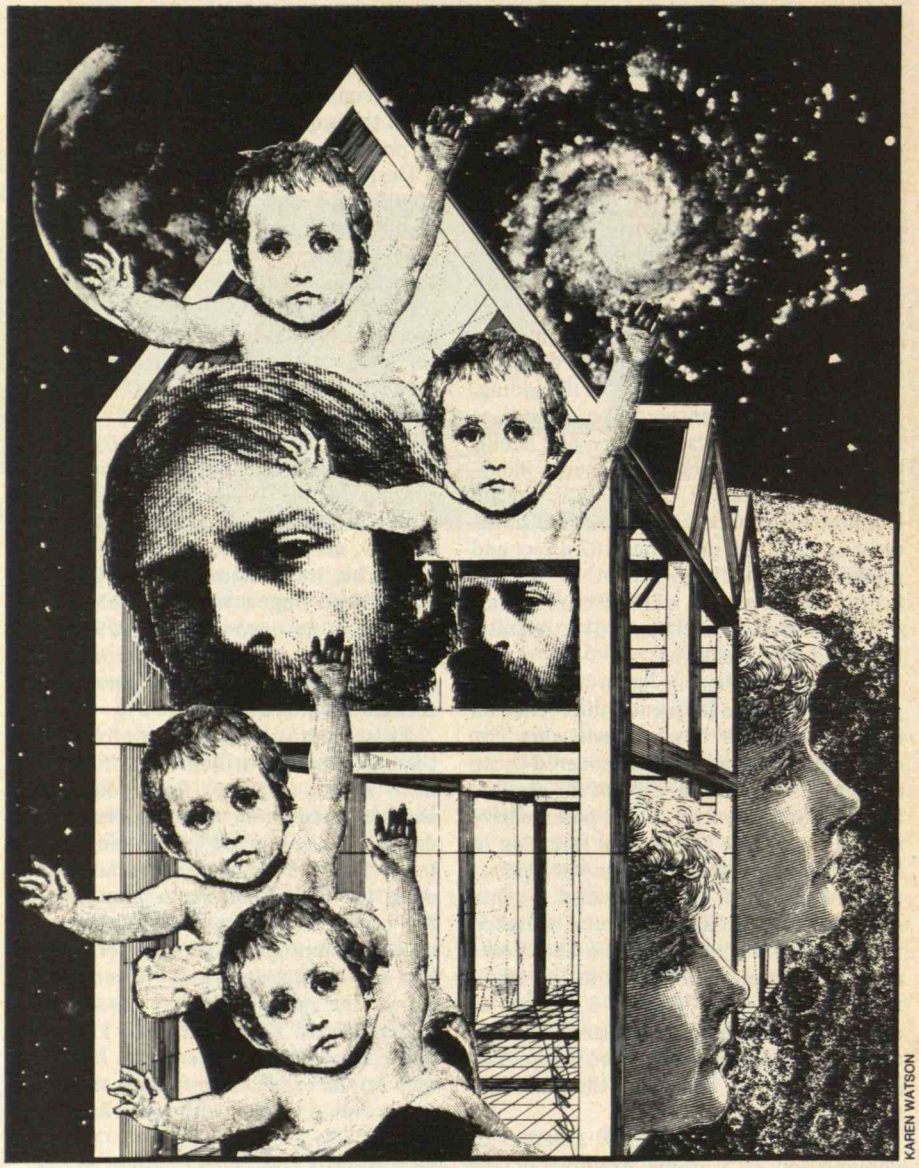
See "Oil Shocks and Western Equilibrium" by Robert E. Hall and Robert S. Pindyk, page 32, for another analysis of these issues.

We welcome contributions from our readers to Forum and Special Report. Queries should be submitted to the Forum editor, Technology Review, Room 10-140, M.I.T., Cambridge, MA 02139.

Malthus Revisited

Overshoot: The Ecological Basis of Revolutionary Change
William R. Catton, Jr.
University of Illinois Press, 1980, 298 pp.

Reviewed by Rosalind Williams


KAREN WATSON

MOST of us have been fooled into buying a book because its dust jacket portrays a torrid love scene promising spicy reading, only to discover inside a dreary novel containing one or two mildly titillating passages. William Catton's *Overshoot* practices no such deception. What you see is what you get, and what you see on the dust jacket is a glossary of key terms such as "carrying capacity," "drawdown," and, of course, "overshoot." The main argument of the book is that we must discard familiar historical and political terminology and adopt a new ecological vocabulary. According to Catton's theory of "ecological paradigm," the era between the Renaissance and the present ("the Age of Exuberance") was a brief and unrepeatable episode of prosperity resulting from the discovery of the New World and the exploitation of finite supplies of fossil fuels ("drawdown"). This era has ended, forcing a human population that has proliferated beyond the carrying capacity of the environment ("overshoot") to face drastic declines in living standards, increases in mortality, or both. Our only recourse, he says, is to try to minimize the severity of the coming "crash."

Catton's vocabulary may be unfamiliar, but his general themes are not. Garrett Hardin writes that it is "one of the best works of this sort that I have read." Hardin is referring to the numerous similar books recently published, including his own, but these are part of a far older tradition of warnings about the grim implications of biological inevitability. Since the advent of the Industrial Revolution, hopes aroused by people's technological conquests of nonhuman nature have been undermined by anxieties about the implications of people's biological nature.

The steam engine and Malthusianism, these two visions of the human prospect that emerged simultaneously, have since coexisted in an unresolved dialectic. During the nineteenth century, Malthus's ideas merged with popularized Darwinism. The resulting "lesson" of biology was that in competition for limited food supplies, the fittest would survive unless aided by state assistance, charity, liberal immigration laws, or other well-meaning but misguided policies. Speculation about superior and inferior races has subsided, and since World War II the dominant vocabulary of biological gloom has not involved race and heredity but ecology and environment. Still, the underlying fear persists that the achievements of humankind will be swamped by a rising tide of barely surviving humans.

But scientific prophecies are still prophecies and so incapable of proof; prophets can only try to persuade others to believe them. One common method is to use quantitative techniques, which can be as simple as Malthus's ratio between geometric expansion of population and arithmetic expansion of food supplies or as elaborate as Jay Forrester's computer models. Reliance on numbers is both a scientific device to achieve precision and a literary device to convince people in a quantitatively minded age. But as Catton reminds us, it is impossible to assign a precise value to the crucial variable of the earth's "carrying capacity." Finally, no matter how much prophets try to quantify, their predictions inevitably involve value judgments. They foresee not only how many people will survive but also who will survive and what kind of life they will have.

Consequently, works of this sort should ultimately be understood not as a branch of

science but as a literary genre. Far from being a denigration, the appreciation of this type of inquiry in literary terms confirms its power as a potentially humanistic endeavor, rather than allowing its dismissal as a weak competitor to laboratory sciences. A work like *Overshoot* is most significant and compelling when read in the tradition of Jeremiah: "And I brought you into a plentiful land to enjoy its fruits and its good things. But when you came in you defiled my land, and made my heritage an abomination . . . Your ways and your doings have brought this upon you. This is your doom, and it is bitter."

How persuasive a prophet, then, is Catton? He writes a flat, schoolmasterly prose (he is a professor of sociology) occasionally enlivened by striking statistical demonstrations. The book lacks wit but offers abundant earnestness, and through sheer repetition the reader begins to think according to an "ecological paradigm." This is not a subtle tactic but it is effective; Jeremiah can be repetitious too.

Biology as Destiny

I found Catton's arguments depressingly convincing, but then I too am a liberal-minded American academic with similar guilts, anxieties, and interests. Readers of other backgrounds may well be unconvinced. Captains of industry and finance could argue that technical processes as yet undiscovered will save us all. Political radicals could argue that ecological alarmism expresses a bourgeois fear of losing privileges; that what Catton calls the Age of Exuberance is more properly understood as the age of industrial capitalism; and that world poverty is due far less to biological determinism than to unjust political and economic structures that must be changed.

Catton tries valiantly to dispel both beliefs, arguing that technological breakthroughs are extremely unlikely and asserting his freedom from class-bound motivations. He will probably persuade only those readers who already believe his predictions. Belief in technological or political salvation, like religious salvation, is basically a matter of faith.

But Catton is reluctant to think in terms of such predisposing factors. He repeatedly cautions that groups usually blamed for current shortages and other economic woes—environmentalists and oil companies, fascists and Communists, whites and blacks, Arabs and Jews—are only scapegoats, or at best messengers of the bad news. No one group of leaders has led to "overshoot": "The end of exuberance was the summary result of all our separate and innocent decisions to have a baby, to trade a horse for a tractor, to avoid illness by getting vaccinated, to move from a farm to a city, to live in a heated home, to buy a family automobile and not depend on public transit, to specialize, exchange, and thereby prosper."

Catton says we were acting according to our biological nature, just as yeast does when introduced into a wine vat. In both cases, the result is proliferation, destruction of the supporting environment, and "die-off." We are victims not of conspiracy, not even of stupidity, but of fate.

This is not the book of Jeremiah after all but a Greek tragedy. To Catton, Hardin's famous "tragedy of the commons" is a contemporary version of the ancient drama that pits individual will against impersonal forces that inexorably shape its destiny. Like tragic heroes, we should submit to our destiny not with futile resistance but with lucid awareness of its necessity and our own unintended complicity.

The benefit of the tragic view of life is that strength comes from shedding illusions and evasions, from confronting reality, no matter how bleak. We sorely need this catharsis. Only by ridding ourselves of the dream of universal material prosperity can we finally turn to the task of creating another future. But while Greek fatalism may be bracing, American culture is far too activist, restless, and optimistic to stop there. Not even Catton can resist asking, "But what can we *do*?" At the end, Catton advocates "ecological modesty," reliance on renewable resources, revision of cultural values away from consumption, conservation of remaining supplies of fossil fuels, and strict enforcement of legislation such as the Endangered Species Act and the National Environmental Policy Act (NEPA). Feasible recommendations such as the latter seem pathetically ineffective to avert global overshoot, while the sweeping recommendations hardly seem feasible.

In *Muddling Towards Frugality,* Warren Johnson suggests that we can face the future more constructively by acting not as tragic heroes but as comic ones. Johnson's comic hero eschews noble ideas and concentrates instead on the basics—survival, family and friends, simple pleasures. While commendable for his modesty and flexibility, this hero is disturbing for his radical self-reliance. His lack of any sense of social solidarity suggests light-hearted survivalism. He too is at the mercy of inexorable outside forces but lacks the tragic hero's clear-eyed recognition of his destiny.

To confront the future usefully, a third ancient tradition is needed, that of Jeremiah. The Old Testament prophets declared that people live not under an impersonal fate beyond good and evil but under a personal God who judges good and evil. Catton may be right that our present predicament was not caused entirely or even mostly by evildoers, but there certainly are those who are exploiting shortages and making our situation far worse. Catton is obviously no friend of oil companies, and he suggests suppressing the advertising industry for its incitement of useless appetites. But because he emphasizes the cosmic view, he does not sufficiently address particular groups and institutions that should be judged and changed. No paradigm shift will alter these social, economic, and political structures; general habits may change only after these structures are changed.

We need tragic and comic vision, but we also need the vision of the Biblical prophets, who in tones of moral indignation denounced the sinful, proclaimed the obligation of society to care for widows and orphans, and recalled humankind to the paths of justice, mercy, and righteousness.

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A Paragon Unveiled

Mathematics: The Loss of Certainty
Morris Kline
New York: Oxford University Press, 1980, 366 pp.,$19.95

Reviewed by Joan Baum

FOR many students who think about it for the first (and maybe last) time, life has two great, albeit unequal, mysteries: how can you look it up if you don't know how to spell it? and why is Euclid's fifth axiom about two straight lines cut by another straight line called the "parallel" postulate? The first question, of no significance, drives most intelligent adults crazy; the second one should—but doesn't.

Why do English and mathematics, disciplines with theoretical foundations and rules, tolerate the arbitrary and the unsatisfactory? Why fret over Euclid's wording when Euclid's world is suspect, Euclidean distance being mostly for the birds (only crows fly as the crow flies)? Because much about mathematics seems to make no sense, such "mysteries" become easy excuses for student hostility or indifference.

Intellectual histories attempt to explain such peculiarities and encourage appreciation of a discipline. The problem is, they usually come along too late to change attitudes—long after high school, anyway—and they wind up addressing only the committed or the professional.

According to Morris Kline, professor emeritus of mathematics at The Courant Institute at New York University and prolific author, the philosophies of *Mathematic Thought from Ancient to Modern Times* (the title of one of his earlier books) constitute a "drama" that resembles Greek tragedy: the triumph of loss. Professor Kline begins his story in ancient Greece, a world of certainty, proof, and abstraction, and a Greek sense sets the tone for his dénouement: mathematics "is a human construction, and every attempt to find an absolute basis for it is probably doomed to failure."

Chipping Away at the Edifice

In the beginning, meaning Greece, was the word, and it was "geometry," meaning measurement of the land but eventually representing a basic tradition of abstraction, deductive reasoning, and a unified body of truths about nature. This glorious state of affairs, when a unified mathematics was the "pride of human reason," continued for about 2,000 years despite a chipping away at the edifice by increased attention to arithmetic, algebra, and the calculus and challenges to Euclidian hegemony.

By 1900, disaster had set in. Interestingly, Professor Kline uses lines from Wordsworth to signal a kind of noble resignation about the loss, as though "still, sad music of humanity" could compensate for music of the spheres. However, Kline does not note that among Wordsworth's friends was the famous William Rowan Hamilton, whose "quaternions" (numbers in vector analysis) and non-Euclidean investigations inevitably helped bury the great myth of mathematics as a unified field, and of mathematical inquiry as a system of "indubitable and irrefutable conclusions."

Ironically, when it became clear that the king was dead, it also became clear that the very brilliance that administered the death blows would forever prevent another single king from occupying the throne. Mathematic design was not inherent in nature nor could it be said to be a pure construct of the mind. False proofs, blunders, "vigor without rigor" had ruled the day, particularly from the Renaissance on. New numbers—irrational, negative, complex, transfinite—

and new algebras created new power and new confusion. Mathematical results and successes in science proliferated but were not soundly based or logically justified.

By 1900, despite agonizing attempts to reclaim paradise with efforts to "axiomatize" everything and to heal breaches with set theory, contradiction and paradox persisted. Those who would shore up the crumbling edifice divided into four conflicting camps: logicism, intuitionism, formalism, and set theory. By 1930, a war was underway among these schools and within each camp, with leading advocates recanting or seeking new refinements. From Professor Kline's account, it seems not so much that the Parthenon had been destroyed as that a Tower of Babel had been erected in its stead, with mathematicians living in screened-off apartments, playing complicated chamber music only for themselves.

In attacking "isolationists" (theorists especially interested in abstract algebra, topology, and refinements of analysis), Professor Kline not only strengthens his historical theme but presents a timely controversy. If his figures are correct, 90 percent of mathematicians are ignorant of science and content to remain so in violation of the rich tradition of mathematics as both the queen and the handmaiden of science.

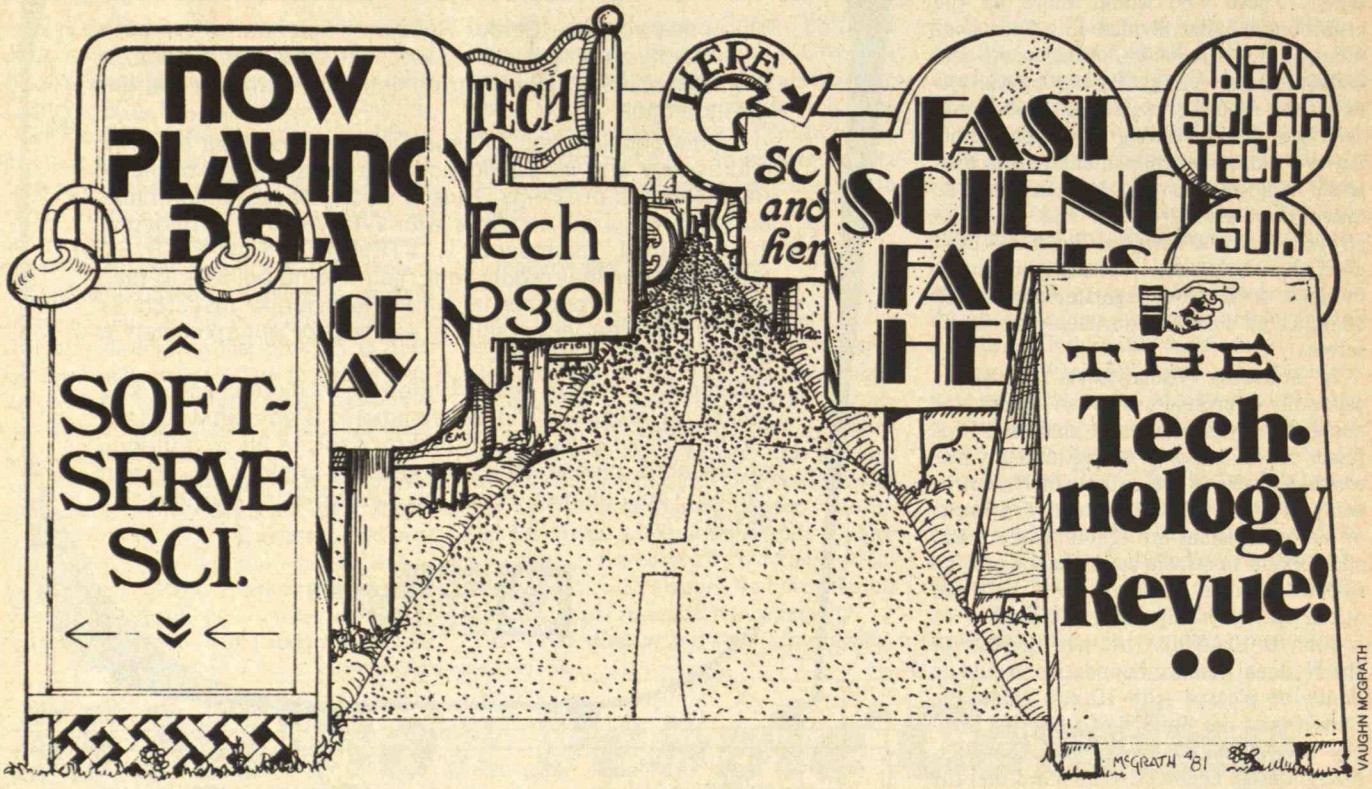
John B. Slaughter, the new director of the National Science Foundation, would no doubt be pleased with Kline's emphases. Speaking to the Council of Scientific Society Presidents this past November, Dr. Slaughter, an engineer, announced that the NSF will change its direction from basic research to projects in engineering and applied science. Moreover, given recent moves in Congress, Kline's attack on the "sterile tinkerers" seems direly prophetic: the House Subcommittee on Science, Research, and Technology is considering a bill to redistribute the $1 billion a year allotted for research and education to a new and separate national technology foundation. What mathematicians will not do themselves, Professor Kline warns, will be done by others. However, his argument is not essentially political. The loss of mathematical certainty was historically inevitable, but isolation can, and should be, avoided.

Kline's appeal is to history, where mathematicians who were also scientists, the so-called "natural philosophers," made advances despite despair and uncertainty. Still, the pattern of renewal, failure, and advance was not uniform. Certain injuries, Kline admits, were fatal, and despite the impression of some that math is exact and monolithic, the loss of mathematical certitude is permanent and a "tragedy of the first magnitude." □

A frequent contributor to this column, Joan Baum is associate professor of English at York College of the City University of New York and a faithful student of mathematics.

The Great Science and Technology Bazaar

by Fred Jerome



CARL Sagan strolls nonchalantly through the galaxies, across the eons, and—via the magic tube—into millions of American living rooms, his mellifluous voice unraveling the secrets of the cosmos. Walter Cronkite sits against a backdrop of planets instead of politicians and patiently explains the universe. And our children, glued as usual to the TV set, are watching science on *3-2-1 Contact* instead of their usual afterschool cartoons.

We are in the midst of a science information explosion. Publishers have been racing into print with slick new science and science-related magazines such as *Omni, Geo, Science 81, Science Digest, Discover,* and *Next,* not to mention the *New York Times'* weekly "Science Times" section and the continuing excellence of *Scientific American* and *Science News.* All of these are aimed at a general audience and all claim circulation and advertising success.

More far-reaching are a host of expensive, widely promoted television series on science and technology. In addition to Sagan's 13-part *Cosmos,* Cronkite's *Universe,* and *3-2-1 Contact,* at least two new science shows are in preparation at NET and ABC. Add to these the continuing popularity of the PBS science documentary series *Nova* produced by WGBH in Boston and there can be little doubt that the mass media have awakened to the prime-time potential of science and technology.

But few blessings are unmixed. The very commercial success of the current media boom in science and technology raises serious questions about the nutritional value of this new food for thought suddenly added to America's intellectual diet. Commercial success, of course, does not necessarily imply commerciallike treatment. But in the current rush to sell science and technology to the public, the disturbing word is "sell."

There are already troubling indications that producers and sponsors will opt for Nielson over Newton or—more to the point—over Darwin. Boyce Rensberger, former chief writer for *3-2-1 Contact,* has reported that the subject of evolution was verboten because its producers feared that "Bible belt" stations would cancel the show. According to Rensberger, the topic of animal reproduction was given the same taboo. (On a more hopeful note, Sagan's treatment of evolution for *Cosmos* was excellent.)

Another disputed area is whether the public can or should really learn science from the new TV programs. One recent article quoted Carl Sagan and Walter Cronkite at odds over this issue, with Sagan criticizing the science-as-entertainment approach and Cronkite declaring that the aim of his program "is to excite interest among those who are not now interested."

Out of Focus

But the most fundamental question involves the focus—indeed whether there should even be a focus—of the suddenly popular science media. What kind of material should the new magazines and TV series concentrate on? Do the editors and producers have any social responsibility in selecting subjects or should they just put out whatever "sells"? This question is crucial today because never before has our nation faced so many critical policy decisions involving science and technology—decisions that will affect not only our quality of life but our national and international role.

Unfortunately, the publishers, producers, and sponsors of the new science and technology media seem reluctant to deal with policy questions. Some media managers undoubtedly will tell us that the public won't "buy" a serious examination of such issues: what sells is wow! and gee whiz! and eureka, I found it! Besides, gee-whiz science lends itself so much more simply—and less controversially—to the graphics of TV and magazine covers.

Not surprisingly, a review of recent issues of the three newest science magazines—*Discover, Science Digest,* and *Science 81*—reveals a veritable cornucopia of articles on discoveries and "breakthroughs" and almost nothing on science policy. And while the stories themselves are not uninteresting, they often seem weighted in the direction of sensation rather than substance: "They Dared to Document Sex," "The Secret of Life," "Life on Mars? The Question That Won't Go Away," and so forth. Certainly, legitimate scientific and technological developments should be reported and even headlined, but the present emphasis leads to media neglect of scientists whose serious comments contribute more to policymaking than flashy reportage. Moreover, editors and readers will no doubt be besieged by hundreds of self-promoting scientists with dubious claims.

Twins Reunited

A particularly disturbing example of this sales approach was the cover story in the November *Science 80*, "Twins Reunited," on a research project at the University of Minnesota that examined 15 sets of identical twins raised apart since birth. It is replete with anecedotes about twins who, despite their separate upbringing, had similar likes, dislikes, and habits. Four pages of such "data" are trotted out to bolster the assertion that "more of human behavior is genetically determined or influenced than we ever supposed." At the heart of the study is the IQ question, and here the article claims that "of all the psychological traits measured in identical twins, this one [IQ] shows the highest degree of similarity." However, several sentences later we learn that the IQs "vary considerably" for a "few" of the pairs of twins, and that the "variance appears to reflect large differences in education."

This particular article is a popularization of a piece printed earlier in the respected journal *Science* by the same author. However, in the *Science* article, Gordon Allen of the National Institute of Mental Health and head of the International Twin Society is quoted as not believing the study will find any "new and unique answers." The author explains that "the sample will not be large enough for that, and besides, too few of the twin pairs were reared in environments so radically different as to bring genetically based behavioral similarities into stark relief."

(Continued on next page)

He Is the Very Model of a Modern Dr. Frankenstein

by Steven J. Marcus

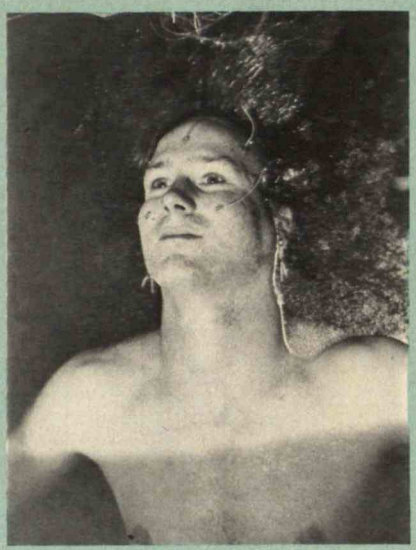
"IT'S the most terrifying experiment in the history of science," says the voice-over in the television ad, somewhat redundantly, amidst thunderous rumblings, erratic flashes of light, a wildly distorted head that is screaming in agony, undulating pipes that are bending and twisting like rubber bands, and a flood in a weirdly luminescent subterranean vault. In case the viewer is still unsure, the voice adds: "And it's going out of control."

The screaming head belongs to Dr. Edwin Jessup, distinguished scientist, in one of the *Altered States* from the movie of the same name. He is rapidly changing—devolving!—with the aid of a mushroom-and-blood elixir. His aides aren't much help—one has fainted from the intensity of the light and another has been physically thrown into unconsciousness by the force of it all. Only his faithful wife has the chutzpah, and the apparent immunity to every possible technological mishap, to brave the zaps and the water and the fog to pull the naked, wired, and injected Dr. Jessup from near oblivion.

The hullabaloo takes place at no less august a setting than the Harvard Medical School (way downstairs, however), and as the voice told us, it's a scientific experiment. But where is the science? And this is an experiment? Where, by the way, is the fire department, not to mention the maintenance people and disgruntled neighbors?

This is no scientific experiment; it's a moviemaker's *version* of one. And the experimenter is a hip Dr. Frankenstein, a thoroughly modern stereotype of the mad scientist. Arrogant, forceful, insatiable, relentless, brilliant (we are told), single-minded in the pursuit of knowledge (he says), we get a continuous stream of scientific clichés and breathtaking leaps of logic. Jessup has tasted of the fruit of the fungus once before—during his requisite sojourn among isolated, wise, and wizened Mexican Indians—and his stated goal is now to go "beyond mass, beyond energy, back to the first thought." This is not language that would impress the bureaucrats at NSF or NIH—no wonder he's down in the basement, at odd hours, with the minimum number of subjects.

The ominous-looking tank becomes his vehicle for a trip backward in time. The chemical unlocks ancient "memories," the data stored in his (and, presumably, our) every cell that enables him to literally return to the source. Jessup does partly succeed one night: he becomes an apeman who terrorizes the nightwatchmen and a few dogs, raids the zoo, attacks some unsuspecting mountain sheep, and dines on his prey directly and unceremoniously. Science isn't pretty, Ed.



But not to worry; it was only a temporary genetic rearrangement. Except for some occasional relapses—arms and bellies distending, the sprouting of hairy sixth toes, and a spectacular imitation of Reddy Kilowatt—the scientist returns to tell the tale. Won't more than a few eyebrows be raised when his account of all this appears in the professional literature?

As the reader may have gathered, and as the viewer can see within a few minutes, this is not a movie about science. It's a horror movie—a thriller—with a pseudo-scientific veneer. The premise and dialogue bear as much semblance to science as *The Dove*, a parody of Bergman films with a quasi-Yiddish soundtrack, resembles life in Sweden.

This is no parody, however—at least, not by intent. With Paddy Chayefsky as writer and the creative and highly unorthodox Ken Russell as director, the viewer expects the unexpected. It's a trip, all right, but to where? It's not only silly science but a nonstory with a terribly anticlimactic ending. After traveling to hell and back, one leaves the theater wondering, "What did I learn? What was the point?"

(Continued on next page)

If Dr. Jessup is really a scientist searching for truth, why does he choose such an unlikely, tortured path? Why not choose something prosaic, like a cure for cancer?

Most scientists do not do dumb and dangerous things on purpose. They start out well-meaning and risk-averse. They carefully recheck their objectives as they go along. They enlist the aid and advice of colleagues. They form teams for experiments that are too subtle or complex for one researcher to adequately handle alone. They don't immediately jump to cosmic conclusions. And experiments, to have enduring value, must be replicable; not many scientists would strap themselves into a chemical time-travel device—actually, in *Altered States*, it looked like a cross between a washing machine and a composting toilet—and sail off into the unknown. Any scientist with an ego as big as Jessup's would at least try to maximize his or her chances of being around to collect the Nobel Prize that would surely follow after transcending all that mass and energy.

The mad-scientist image, of course, is only one kind of distortion. Another is the paternal, omnipotent, and impossibly wonderful sage. In the movie thrillers of the 1950s, for example, there was no technological danger—either alien (death rays from another planet) or earthly (mutant cockroaches crazed by atomic testing)—that some all-knowing and lovable scientist, teaming up with a square-jawed air force general, couldn't defuse by the last reel. That science-will-save-us illusion has been steadily losing ground to the opposite extreme, but neither view is very helpful in forming a realistic image of science, its applications, and its limitations.

Scientists should certainly not be exempted from the storyteller's or moviemaker's imagination. And this film is truly imaginative; it's a visual feast. Yet I can't help but worry about the one small step—another in a long and backward series—in public misunderstanding of what scientists can and cannot do. □

Steven J. Marcus is managing editor of Technology Review.

The *Science 80* version omits this significant paragraph. Instead, the cover shows an eerie mirror-image scene of rows of clone-like twins facing each other with their hands pressed together as if in some mysterious rite. Not all such stories need to resort to shallow reporting, but once the dominance of gee-whiz journalism has been established, the danger of replacing science with pseudo-science and faddism will be all the greater. This is not to suggest that science and technology journalists should avoid innovation or exploration—there is certainly a legitimate public appetite for developments on the frontiers of research. But there is an equally legitimate interest in—and social need for—discussion of the related policy issues so critical to our time.

The Post-*Sputnik* Generation

Complex, controversial issues involving technological innovation, defense, hazardous waste, and energy require serious *political* decisions regarding congressional funding priorities, environmental and patenting legislation, safety regulations, and the like. Some media managers may avoid such controversies because differing expert opinions may leave readers and viewers with a disturbing sense of uncertainty. How much cleaner and easier to describe researchers who add chemical A to chemical B and come up with a new drug to combat senility. The truth, of course is never so simple. As Lewis Thomas wrote recently, "Science is founded on uncertainty. Each time we learn something new and surprising, the astonishment comes with the realization that we were wrong before . . . I cannot think of a single field in biology or medicine in which we can claim genuine understanding."

Policy decisions offer no anchor of certainty in the sea of doubt around us. But they *are* comprehendible, and public perception of those policy choices has itself become a major factor in the decision-making process. A public that understands the issues, including the views of responsible though differing scientific experts, is more likely to have confidence in and even enthusiastic support for the resulting decisions.

But some people argue that the public would be bored by policy controversies; that the public wants escapism, pizzazz, and health and consumer advice in this "me generation." To be sure, the phenomenal popular interest in health foods, consumer safety, and medical breakthroughs reflects this concern with self rather than social consciousness. Yet the new popularity of science and technology magazines and TV programs reflects more than the need to survive in today's dizzying society.

People worry about gas lines, certainly, but interest in this country's energy options is intertwined with a growing concern about our national security and the need to end dependence on imported oil. Similarly, the public's romance with space technology involves a strong sense of national pride and, more subtly perhaps, the importance of exploring new frontiers. And there is real concern as well as curiosity over the revolution in microbiology and the phenomenal growth of computers in virtually every aspect of our lives.

In fact, the post-*Sputnik* generation, weaned on space flights, computers, Three Mile Island, and Love Canal, is hungry for knowledge of science and technology—including the policy debates so critical to our future. As Michael Arlen has written, "It wouldn't kill us to know a little bit more about the so-called boring stuff, and it might in fact kill us *not* to know about it." There is no reason why a program on energy options, the impact of computer technology on the American home, or genetic engineering has to be boring. With the tremendous creative capacity at their disposal, media wizards can make these subjects as lively in print and on camera as they really are. Media managers who fear the public will be bored by science policy ought to remember that just a few years ago they were insisting that the public would be bored by science and technology.

Coverage of science and technology is still in its infancy, and it is perhaps premature to draw conclusions; the latest issues of the new magazines seem to indicate growing coverage of science policy. The present wave of popularity provides an unprecedented opportunity for the media to enhance public awareness of key policy issues. A creatively designed television program on the momentous options involved in recombinant DNA research, for example, could contribute to reviving our national sense of exploration and confidence. If media managers respond to the current interest with nothing more than a sales convention for the latest "sensations," it would be a tragic waste. □

Fred Jerome is public information director of the Scientists' Institute for Public Information in New York. He teaches journalism at New York University and the City University.

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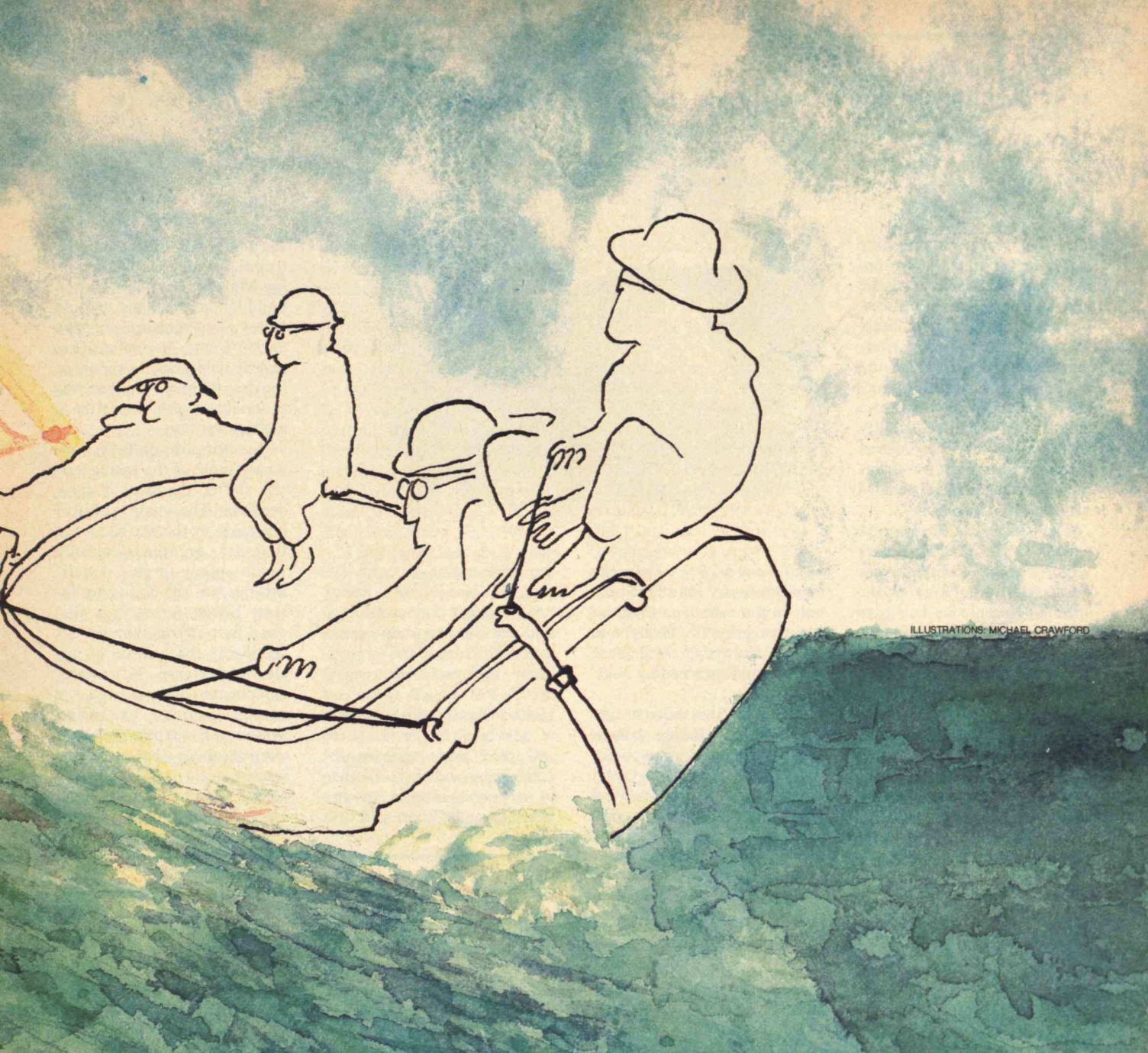
Basing the MX Missile: A Better Idea

by Sidney D. Drell and Richard L. Garwin

Drag strips in Nevada and Utah have been proposed to counter Soviet nuclear warheads with American concrete shelters. But a "smallsub undersea mobile" (SUM) deployment could provide a survivable, less expensive, and more effective alternative.

ONE of the first acts of the Reagan administration was to take a hard look at the Carter administration's plan to base 200 new MX missiles in 4,600 concrete shelters in Utah and Nevada. In fact, Secretary of Defense Caspar Weinberger, in announcing the study, said that he was particularly interested in the possibility of basing the MX at sea instead.

This was the latest installment in a major 20-year effort by both the United States and the Soviet Union to ensure that their strategic nuclear forces will not be vulnerable, overall, to destruction by a preemptive (that is, first) strike. Thus, both countries have based their intercontinental ballistic missiles (ICBMS) in hardened underground silos highly resistant to the effects of a nuclear warhead. Likewise, both have deployed a sizable portion of their nuclear warheads on ballistic missiles to be launched from nuclear submarines. Moving invisibly under the ocean's surface, these com-



ILLUSTRATIONS: MICHAEL CRAWFORD

prise, now and for the foreseeable future, a highly survivable force. Finally, to maintain a broad diversity of forces with differing vulnerabilities, operating characteristics, and failure modes, the United States has maintained and repeatedly upgraded a strategic bomber force that would survive by being launched on warning of impending attack.

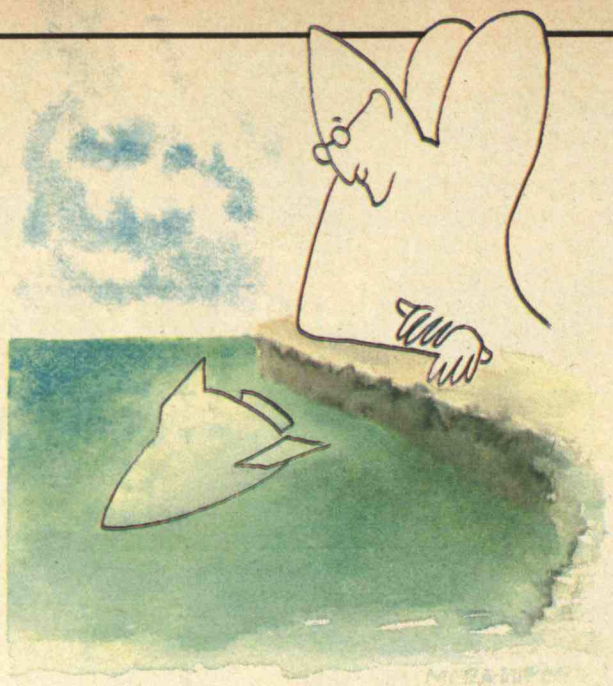
Minuteman Vulnerability

In the 1980s, two technological improvements threaten fixed land-based systems such as the Minuteman, the bulwark of the American ICBM forces, with obsolescence: the achievement of very high accuracy and reliability for ICBMs, and the extensive deployment of "multiple independently targetable reentry vehicles" (MIRVs) that enable individual missiles to effectively threaten several ICBM targets.

The United States is particularly concerned about the improved accuracy of Soviet missiles and their rapidly growing numbers of MIRVed ICBMs, many deployed with 6 warheads (SS-19s) or 10 warheads (SS-18s). U.S. defense officials have claimed that these weapons, when fully deployed by the early 1980s, could destroy as much as 90 percent of the present U.S. ICBM force. Of course, such an attack would be enormously difficult to execute successfully; it would require nearly simultaneous and very accurate arrival of some 2,000 Soviet warheads at the 1,000 American Minuteman silos, and the Soviet missiles would be flying on trajectories never before flight-tested. Therefore, many experienced observers (both military and civilian) view Minuteman vulnerability as little more than a paper-and-pencil threat. The Soviets nevertheless appear to be headed on a path that will soon reduce U.S. confidence in the invulnerability of

The Politics of the MX

by James Fallows



In the two years since the Carter administration decided to build the MX missile and base it in the Southwest on a "drag strip" (politely known as "linear grids"), arguments have raged about the system's military, economic, environmental, and diplomatic effects. Yet the probability that the system will be built as planned, never high, has dwindled further since the beginning of 1981.

The Carter administration embraced the drag-strip system less out of conviction than because of political constraints. Because he had cancelled production of the B-1 bomber and the deployment of the neutron bomb, Jimmy Carter was not eager to give his opponents another item for their list of his steps toward a weaker defense. Because his administration had staked its political and ethical capital on passage of the SALT II treaty, Carter was willing to take the steps necessary for a favorable vote in the Senate on the treaty, steps generally thought to include increasing the defense budget and proceeding with the MX.

But from the moment the plans for the basing system were announced, they met with lukewarm support and determined opposition. Paul Nitze of the Committee on the Present Danger, who had warned strenuously about "Minuteman vulnerability," said that the drag-strip system would be clumsy and conceptually inelegant. He recommended instead that the United States build hundreds of new silos in the far West and then move missiles secretly from one silo to another in a process known as the "shell game." Others said that the quickest solution would be to put MX missiles into existing Minuteman silos and then build an antiballistic missile system—in violation of the SALT I treaty—to defend the missile fields. Such support as the drag-strip system won was generally of the better-than-nothing variety.

As for opponents, announcement of the basing system shifted the focus of their concern. The main political objection to the MX had been that its greater accuracy would appear to give American missiles the ability to destroy Soviet forces in a surprise first strike, thereby destabilizing the balance of nuclear deterrence. Afterward, complaints changed from the missile itself to its basing system. Environmentalists warned about the damaging impact on the topography and scarce water supplies of the Great Basin region. A govern-

its land-based strategic forces.

The loss of the Minuteman force would not mean the loss of the entire U.S. retaliatory capability. The seaborne and airborne components of our strategic triad are considered both highly survivable and capable and are continually being improved at great cost. For example, of the 31 Poseidon submarines operating for the last decade, each with 16 14-MIRV Poseidon missiles with a range of 2,500 nautical miles, two have already been refitted with 16 8-MIRV Trident I missiles with a range exceeding 4,000 nautical miles and warhead yields in the 100-kiloton range. The longer missile range greatly increases the subs' ocean operating area. Soon the first 24-missile Trident submarine will join the fleet, carrying the same Trident I missiles but capable of carrying a much larger 6,000-nautical-mile Trident II, although no decision has yet been made to develop and produce Trident II. In 1982 the bomber force will begin to carry thousands of long-range air-launched cruise missiles that will substantially increase the bomber's firepower and remove the need to overfly and penetrate the extensive Soviet air defenses.

The loss of Minuteman would not compromise the U.S. retaliatory capacity for assured destruction. Even today, loss of the ICBM force would leave intact about three-fourths of the total number of nuclear warheads in the currently deployed U.S. strategic forces and about two-thirds of their total throw-weight. However, a fundamental question remains: Should the United States accept a decrease in its margin of safety as a result of new Soviet deployments? Both Congress and the executive branch agree that to simply ignore the growing vulnerability of our Minuteman force is not an acceptable policy for the United States. Thus, the issue is not whether but *how* to respond to the growing threat.

The MX Missile System

The Carter administration responded to this problem by recommending the deployment of a large new MX missile in a land-based "multiple-aimpoint" system. At 92 inches in diameter, 71 feet in length, and a design weight of 192,000 pounds, the MX is the largest missile consistent with the provisions of SALT II. (Although this treaty has not yet been ratified by the U.S. Senate, the Reagan administration has stated explicitly that it will abide by these provisions so long as the Soviet Union also complies, pending the estab-

ment official calculated that building the shelters and drag strips would consume a substantial fraction of all the cement the United States could produce in a decade. Official estimates of the cost rose from $30 billion to $50 billion within a few months, and opponents threatened to tie up the system for years with environmental impact statements and endless litigation.

Ronald Reagan came to office more sincerely committed to the missile than Jimmy Carter had probably ever been, but he encountered new obstacles to proceeding with Carter's basing plan. In postponing ratification of the SALT II treaty, Reagan altered the fundamental logic of the MX, which had rested on careful calculations of how many warheads the Soviets would have to fire against it. A series of government reports, including one from the Office of Technology Assessment, emphasized the gravity of the environmental effects and the greater technical feasibility of putting the MX missiles on ships or submarines instead of land. Secretary of Defense Caspar Weinberger said that he was attracted by the idea of putting the MX to sea and thereby avoiding the environmental tangles, and that the drag-strip plan "has an element of the unreal in it. There's no doubt about that."

Weinberger also began one of the two processes that seem likely to determine the system's fate. In March he appointed a 15-member panel composed largely of military officers and scientists and headed by Charles Townes, a Nobel-laureate physicist from the University of California at Berkeley, to review the basing plan. The panel is supposed to report its findings by July 1, and Weinberger has said he will then make up his mind.

The other process is being played out among the people and politicians of Utah and Nevada, the states that would house the missiles and could thereby become, in the infelicitous phrase of Air Force Chief of Staff Lew Allen, a "nuclear sponge" during a Soviet attack. Three of the states' four senators are prominent Republicans—Orrin Hatch and Jake Garn of Utah, and Paul Laxalt of Nevada, a close friend of Reagan's. (The other senator, Howard Cannon of Nevada, is a Democrat but has been more enthusiastic than the others about the basing plan. Nevada's Democratic representative, James Santini, has been the most vigorous opponent.) All three Republicans say that opinion in their states is deeply divided, that of course they and their constituents will patriotically bear the burden if the nation's security is at stake, and that they hope like crazy that the experts will decide to put the missile elsewhere.

Senator Garn says that his preference is to put the MX in Minuteman silos and defend them with an ABM system. If it comes to the drag strip, he and the others have supported a "split-basing" plan that would locate half the missiles in New Mexico and Texas. They cite the precedent of the Minuteman missile, which was deliberately dispersed among half a dozen states to minimize the impact on any one. But there has been little enthusiasm from New Mexico and Texas for such a plan.

"We feel that it's the worst of the alternatives," a spokesperson for Senator Garn said. "We just hope it doesn't turn out to be the only practical choice." □

James Fallows is Washington editor of The Atlantic.

lishment of a long-term U.S. arms-control policy.) The MX payload is MIRVed into 10 warheads (also a SALT II limitation), each with an explosive yield in the range of 300 to 500 kilotons. The missile is carried in a heavy steel capsule, requires little maintenance, can remain unattended for many months, and is ready to be launched at any minute.

The MX basing scheme finally proposed by the Carter administration would take the form of 200 "drag strips" in the valleys of Utah and Nevada. Accessible from each strip of roadway would be 23 hardened concrete shelters housing 1 genuine MX missile and 22 high-quality dummy missiles. If they simulated all the observable characteristics of a real MX (such as weight, vibration modes, propellant vapors, and nuclear radiation) in each shelter or on the move between shelters, the dummies would force the Soviet Union to use at least 4,600 (not 200) warheads to destroy 200 MX missiles.

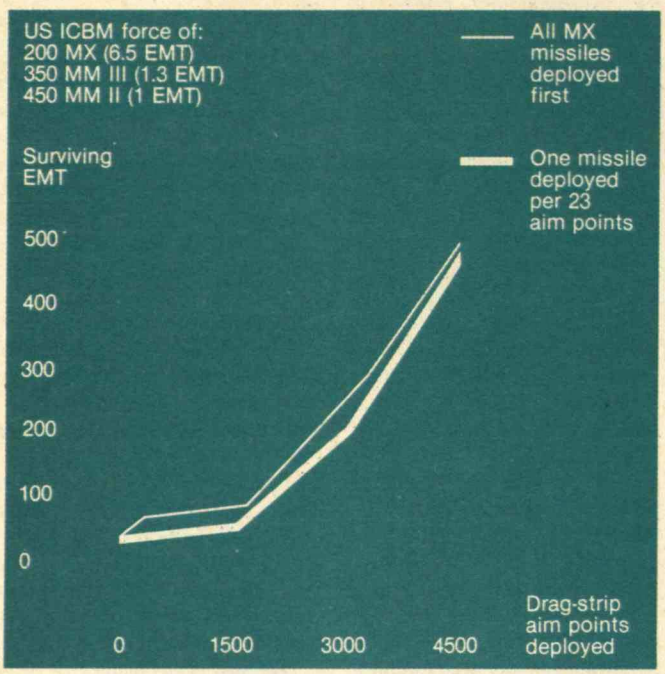
In advocating such a "multiple protective shelter" (MPS) basing mode for the MX missile, the Carter administration argued that the United States must maintain a land-based deterrent force to preserve the diversity of its current triad. Although both the cost and effectiveness of this basing scheme are still being debated, the missile itself is in engineering development. Its first flight test is scheduled for 1983, and regular production of the missile should begin in 1986.

Problems with the Land-Based MX

Because the drag-strip basing mode presents severe operational and strategic problems—it is vulnerable, essentially the entire system must be deployed before it contributes survivable megatonnage, and secrecy, deception, and simulation must be maintained—we do not regard it as a satisfactory response to the threat.

To ensure that some of the deployed missiles in a system of multiple protective shelters will survive, the total number of shelters must exceed the number of threatening warheads. Current U.S. assumptions of survival of 100 of the 200 MXs to be deployed in 4,600 shelters depend on somehow limiting the number of threatening warheads the Russians will deploy. Thus, if one imagines a force of 3,000 accurate, perfectly reliable Soviet reentry vehicles (RVs) available for attack on the MX MPS alone, there would be no survivors until 3,000 silos had been deployed. Indeed, until the number of shelters exceeded considerably the number of available Soviet RVs, the deployment of the

MX-MPS Survivability. It is assumed that 5,000 Soviet RVs (each with a destruction probability of 0.8 against a silo or shelter) are used against the system. The Minuteman II missiles are assumed to have 1-megaton warheads, the Minuteman III to have 3 MIRVs, each of about 200-kiloton yield, and the MX to have 10 warheads of about 400-kiloton yield. (The effectiveness of a submegaton warhead against large targets is determined by the ground area subject to destructive overpressure, while that of a highly accurate force against silos is determined only by numbers of warheads. Thus, the EMT of a force is obtained—as a compromise—by summing the megatonnage of each warhead raised to the 0.5 power).



200 MX missiles would constitute a "silo-killing" force in a vulnerable basing structure—something defense leaders from the Carter administration specifically criticized as unacceptable and provocative.

More realistically, the figure on this page shows the number of surviving U.S. ICBM equivalent megatons (EMT) as a function of the number of MX aimpoints deployed. It demonstrates quantitatively the very limited effectiveness of the first half of the 4,600-shelter force, the first breaks in the curves coming as the Soviets can no longer apply two RVs per shelter, so that 20 percent of the shelters attacked will survive instead of 4 percent. The surviving EMT then rises linearly to 500 EMT when all 4,600 shelters exist. Even this result assumes that deception can be maintained—that the Soviets do not know which of the 23 shelters in a cluster is occupied by a real MX missile.

Such concealment for survivability is necessary if we insist on a survivable land-based missile force within the SALT II limit of 820 MIRVed ICBMs. Cooperative operational procedures are included in the design requirements of the drag strip to give confidence to the Soviets that no more than the stipulated number of missiles (200 MXs) are deployed in the guise of decoys (totaling 4,400). These procedures, including barriers on access roads and removable plugs in ceilings of assembly buildings and shelters to allow for periodic satellite viewing, may provide confidence that no more than 200 real missiles are present. But they do *not* keep the system owners from rapidly deploying hundreds of additional missiles in hardened, prepared, accurately surveyed launch points, should they abrogate the treaty or fail to renew it. This potential for rapid expansion will be a particular concern for the United States if the Soviet Union responds by deploying its own multiple-aimpoint system.

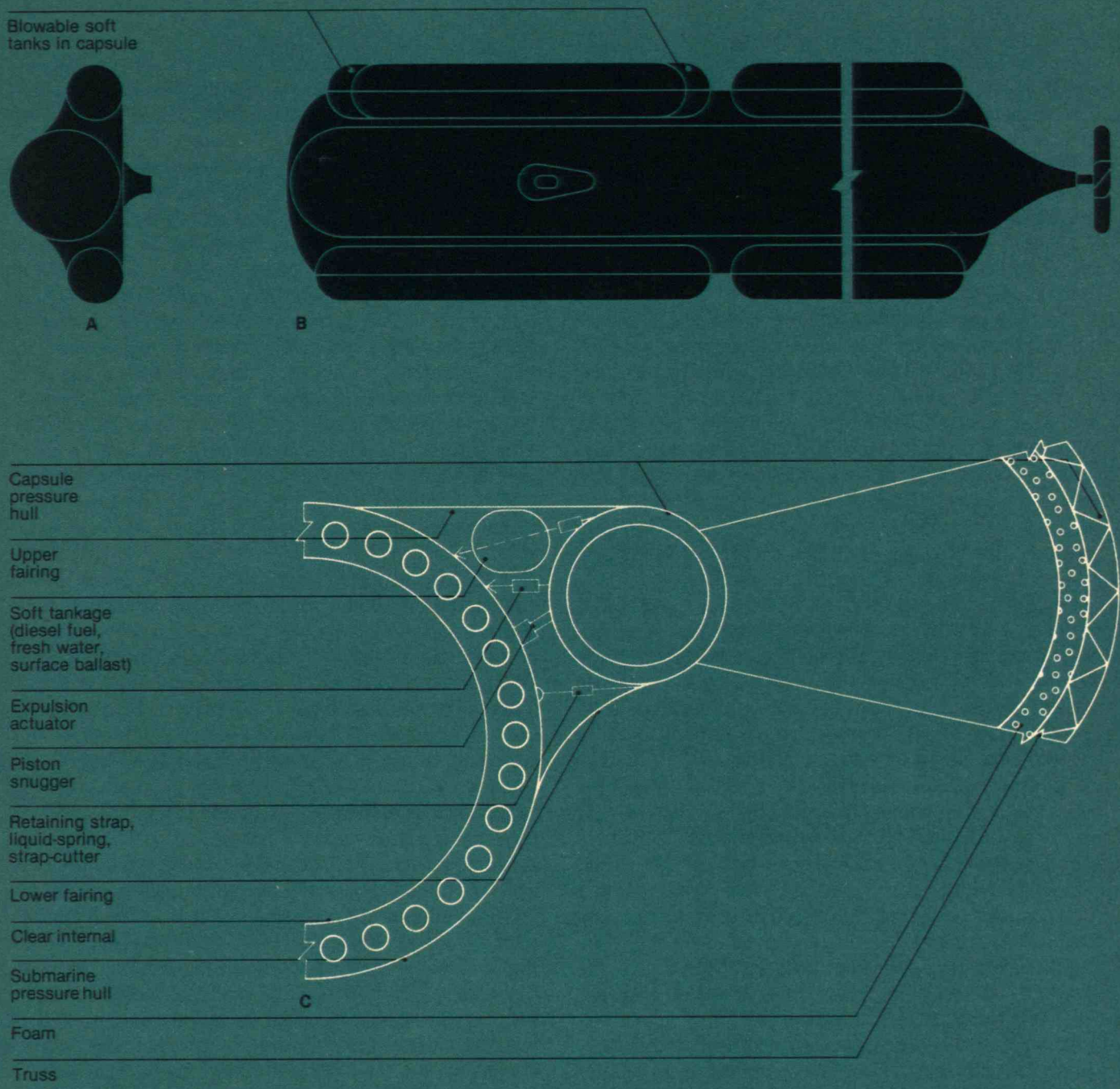
The United States, with its open society, can hardly compete with the closed Soviet society in maintaining secrecy and deception, and the Soviets have a much larger land mass in which to "hide" mobile ICBMs. If Soviet tendencies to follow the United States' lead in weapons programs are any guide, the United States would essentially be choosing Soviet home turf for a competition almost bound to occur.

In the absence of current or future SALT limitations on the maximum number of Soviet warheads, a multiple-aimpoint system provides no assurance of eliminating ICBM vulnerability; it may lead to nothing more than an open-ended race between Soviet warheads and U.S. concrete shelters. Former Secretary of Defense Harold Brown has testified that such competition may be advantageous to the United States, but we fail to see any advantage in balancing concrete holes against additional Soviet warheads, nor do we relish political battles aggravated by questions of environmental impact. Indeed, it would be to our benefit to *ban* land-based mobile ICBMs, the stated U.S. inclination in SALT I, rather than undermine arms control and national security with a program of deceptive basing of land-based missiles.

The SUM Alternative

We favor an alternative basing scheme—a mobile sea-based deployment of the MX on small submarines. We call this the smallsub undersea mobile (SUM) force. SUM retains the major desirable characteristics of the current ICBM force and therefore preserves a healthy diversity in the U.S. strategic deterrent.

SUM would be a deployment of small non-nuclear-powered submarines operating within 600 miles of the continental United States and in the Gulf of Alaska. This concept can be adapted to a wide variety of missiles with ICBM range, but we assume that each submarine will carry two encapsulated MX missiles, mounted horizontally, external to its pressure hull. Limited operating range, short mission duration (no more than four weeks), and a small crew (of about 20 to 25, consistent with safe, efficient operation aided by automation) make possible the concept of small



Figures A and B show side- and plan-view sketches, respectively, of the MX-carrying submarine, while figure C shows a cross-section illustrating how fuel, freshwater, and surface ballast are carried outside the pressure hull in soft tankage. One sees also a detail of the capsule structure, stiffened by an internal truss, and the missile within the capsule, supported gently against impulsive shock load by resilient foam between the missile and the capsule.

submarines with hull displacements of no more than about 1,200 tons. The total displacement of a SUM boat carrying two encapsulated missiles is about 1,700 tons. This is comparable to World War II submarines and about one-tenth the size of the new Trident missile submarines.

SUM consists of four subsystems: the encapsulated MX missile itself; the submarine carrying the missile; the missile guidance system; and specialized command, control, and communications to the vessel.

The primary function of the crew would be to maintain sovereignty over the nuclear-armed MX missiles; guard against piracy, sabotage, and interference; perform safety checks and maintenance; and, of course, operate the submarine. Full power of decision to launch the missiles would reside with the president (or his successor as national command authority), and orders would be transmitted by encrypted communication to the missile. The submarine commander would retain veto power in the event of a failure, as indicated by on-board instrument checks.

With their limited range and duration, SUM submarines have very modest power requirements, so nuclear propulsion is neither necessary nor desirable. Various (relatively inexpensive) propulsion schemes are feasible, including diesel-electric and electric-drive fuel-cell systems. We foresee an initial operation with familiar, tested diesel-electric power, with the submerged submarines patrolling at a speed of about four knots. As in all modern diesel-electric submarines, air would be taken in through a conventional "snorkel" tube for a few hours each day to operate the diesel engine to recharge the battery. This system could evolve in the mid-1990s to one that utilizes fuel-cell propulsion, thereby avoiding any need to snorkel. The technology of fuel-cell propulsion has been extensively tested, but at-sea use of the required fuel and oxidizer still requires further development.

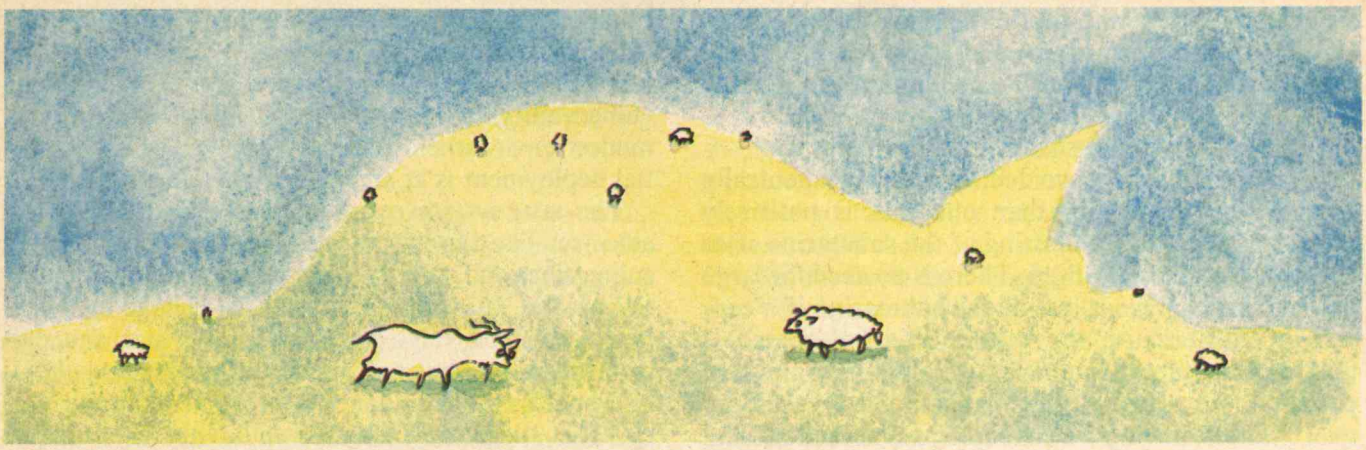
A conservatively designed SUM boat (state-of-the-art for missile capsule and hull) operating at a 200-to-300-foot depth in deep water would be safe from the shock effects of a 1-megaton detonation at distances greater than four miles. By this criterion, more than 20,000 megatons—a number that far exceeds the total Soviet arsenal—would be required to barrage a total SUM deployment area of 1 million square miles. And further fractionation (MIRVing) of their ICBM force would not increase the threat to SUM.

The SUM force can reliably achieve high accuracy comparable with that envisioned for the land-based MX. To correct errors in flight parameters, the missile would receive radio signals during the boost from the Navstar-satellite global positioning system (GPS) or a network of onshore transmitters forming a ground beacon system. Line-of-sight contact with a large and inexpensive network of such beacons could be achieved for submarine launches as far as 500 miles offshore. The duration of missile flight in radio line of sight with ground stations and below ionospheric regions would be sufficiently long that this information would not be distorted by high-altitude nuclear detonations. The ground stations would consist of many unmanned, relatively inexpensive transmitters supplemented by even more inexpensive decoys, and would be turned on only if Navstar were destroyed, minimizing system vulnerability to enemy attack. The SUM submarines themselves would not need a good inertial navigation system but would rely on the very capable guidance system of the MX for accurate locational data, supplemented with occasional radio signals.

The current U.S. submarine missile force has a robust and redundant command, control, and communications (C-3) system, but it is ordinarily viewed as providing less confidence and security than the bomber and land-based ICBM components of the triad. These reservations do not apply to SUM. Because of its coastal deployment, SUM need not rely only on worldwide communication networks. Existing very-low-frequency (VLF) transmitters can be supplemented by equipment at dispersed survivable ground stations or by airborne transmitters much less powerful than those now carried by the navy TACAMO (take-charge-and-move-out) aircraft. Ultimately, other means of communication are available, such as ultra-high frequency (UHF) from satellites, with improved techniques for *receiving* these communications as well. For example, a system of expendable buoys has been proposed for SUM and other submarine-launched ballistic missile systems. A new buoy would be ejected every few hours from the submarine and float awash, while the submarine paid out a fine, slack, insulated wire or fiber-optic thread to receive the signals relayed by the buoy.

The SUM system would maintain about 55 boats with 110 missiles at sea, corresponding to the design goal of survivable warheads for the proposed land-based drag-strip deployment of MX. Although SALT II would limit any land-based MX to 10 MIRVs, it would permit submarine-launched ballistic missiles to have up to 14 warheads per missile, and the SUM-MX could carry 11 to 14 assorted Trident I and Mk-12A

Defense of Land-Based ICBMs



An alternative prospect of defending the real MX missiles with a deceptively based (mobile) antiballistic missile (ABM) system has been discussed. This would require abrogating the limitations on ABMs in SALT I—an even less attractive prospect than the drag strip—and ABMs would not, in fact, provide an *enduring* force. After a first attack, the Soviets could determine the location of the defense as well as the surviving shelters and attack them too. Against such a threat, ABMs would increase the number of Soviet warheads needed to destroy an MX by 10 percent or less.

Ironically, effective defense of the MX or Minuteman force *is* available, and probably allowed under SALT I, in less technologically advanced forms of ballistic missile defense. This would consist of a modest-sized (100-kiloton) nuclear explosive buried some tens of meters underground about one kilometer north of each Minuteman silo. Its detonation would project some hundred kilotons of earth into the air, rendering it impossible for a Soviet warhead to penetrate and explode within lethal range of the silo. In addition to this individual defense, the dust raised to the troposphere would so abrade the protective heat shield of Soviet reentry vehicles (RVs) that their survival to ground level would be doubtful and their accuracy, even if they penetrated, would be impaired.

Individual nuclear defenses would be armed by presidential decision and triggered by small radars a few kilometers north of each silo facing the incoming RVs. Although there is no technical criticism of this system, it is scorned with the comment that "no president will detonate nuclear weapons on U.S. soil until Soviet nuclear bursts have occurred there." The result is that no president has ever been asked whether he wants to develop and deploy such a defense.

A cratering defense of silos not only provides several hours of Minuteman invulnerability after detonation (until the wind carries the high-altitude dust cloud from the Minuteman fields), but it is economical and has a low peacetime environmental impact. Furthermore, even if the system were operated, the radioactive fallout from the cratering explosives would be very small in comparison with the fallout avoided from the enemy RVs. The detonation of 1,000 such bombs would thus contribute less radioactive fallout than 10 nominal Soviet RVs; the defense would need to be no more effective than 1 percent to provide a net reduction in fallout.

Such a cratering defense is both inexpensive and rapidly deployable. The weapon and its emplacement can be bought for $1 million, leading to a price tag for the system (aside from command and control) of $1 billion. It is difficult to understand why this defense has not been sought if we are seriously concerned with Minuteman vulnerability and early remedies.—*R.L.G.* □

warheads.

The encapsulated MX missile makes it possible, as foreseen in the massive Defense Department strategic systems study (STRAT-X) of the 1960s, to provide a clean interface between missile and submarine. The figures on page 25 show the exterior of the submarine, with capsules 3.4 meters in diameter, housing a missile of 2.3 meters, and strapped to a submarine of 6.1 meters. With the missile control center and sophisticated inertial navigation system contained in the missile and capsule, the submarine is a simple electrical relay center for radio signals. These are transmitted from the submarine directly to the missile capsule, where the signal is decrypted and, if verified, launching takes place.

The actual launch consists of freeing the capsule from the submarine, pushing on the capsule with the expulsion actuator to give it a horizontal velocity of a few feet per second, and blowing water from "soft tankage" in the front of the capsule by means of a contained gas generator. The capsule then becomes buoyant and accelerates through the surface of the water. As the capsule broaches, explosive cutters free the forward and rear dome-retaining clamp bands. The missile booster then fires, and the missile emerges from the capsule as from a normal land

The drag-strip basing mode is vulnerable, essentially the entire system must be deployed before contributing survivable megatonnage, and deception must be maintained.

launch. A gas generator in the capsule then inflates an airbag so that it cannot sink and collide with the submarine. The submarine refairs to its initial shape by inflating a rubberized fabric fairing with seawater to about two-pounds-per-square-inch overpressure.

Many problems are avoided by carrying a neutrally buoyant capsule rather than one that is positively buoyant. Thus, no reballasting of the submarine after caspule ejection is required. There is no need for large hard tanks to prevent loss of the submarine if a capsule floods, because the capsule can be ejected if flooded. The fabric water bag weighs a few hundred pounds and is essentially rigid at submarine speeds up to 10 knots, saving the weight, maintenance, and design of a metallic refairing system. The required resistance to shock loading is obtained for the submarine-capsule structure by the arrangement of liquid springs, hydraulic pistons, and multiple retaining bands. Such a system, carrying two missiles, would have an overall submerged displacement of 1,700 tons, a maximum speed of 10 knots, an electric-drive submerged patrol speed of 4 knots, and a 28-day mission duration.

Criticisms of SUM

Charge: *SUM would not be available before the 1990s.*

Some defense analysts allege that construction of a naval base for berthing, maintaining, and resupplying a portion of the SUM force (one-third, if three bases are built) would take more than 12 years, but there is no technical support for this claim. Our own analysis based on conservative practice (allowing 7 years until deployment of the first SUM boat) leads us to conclude that initial system deployment can be realized by 1988, with full deployment completed by 1992.

It is important to realize that each SUM boat contributes to survivable megatonnage for the U.S. deterrent. This is not the case for the drag strip, which will add significantly to the survivable U.S. megatonnage only when it presents so many targets that they cannot all be destroyed (*see the figure on page 24*). The current drag-strip schedule calls for initial deployment in late 1986, with full deployment by 1990. However, this schedule is threatened by serious delays; litigation by citizens' groups in Nevada and Utah on this huge project's environmental impact during both construction and operation, and a proposed congressional requirement that the drag-strip basing include Texas and New Mexico, will surely delay the completion date. Thus, SUM is likely to be a more timely response to the problem of Minuteman vulnerability than the drag strip, and it has a relatively modest environmental impact, particularly if its initial deployment is at an existing naval base.

The SUM system requires no major technological advances like the innovations for developing nuclear submarines and solid-fuel submarine-launched ballistic missiles. It involves a substantial change in *operational* concept, relying on small crew size and efficient operation, but only modest advances in *technology*, such as radio guidance improvements for accuracy. The allegation that SUM could not be available until the 1990s is not only unsubstantiated, it denies the capabilities of our industrial and defense establishments to respond quickly to national needs. Consider that the entire nuclear submarine revolution, including the development of solid-fueled submarine-launched rockets, required only 11 years from the 1949 go-ahead for the *Nautilus* to deployment of the first Polaris boat in 1960.

Charge: *SUM will be more expensive than the drag strip.*

We recognize the inaccuracies and uncertainties of cost estimates for so large a system. Nevertheless, cost *differences* can be assessed with greater confidence because they are computed on the basis of the same set of assumptions. In this context, we estimate that SUM is at least $10 billion less expensive than the drag strip for deploying and operating 850 survivable and effective warheads. We assume here, along with the Defense Department, that SALT II will limit the number of threatening Soviet ICBM warheads. Otherwise, the drag-strip deployment would be even larger and more expensive or require an active and costly ballistic missile defense (in conflict with the SALT I treaty limiting such deployments).

More specifically, a SUM system consisting of 72 submarines, each with 2 MX missiles (but buying 250 missiles and capsules), 1,000 ground-based navigational transmitters, and 3 SUM operating bases, would cost less than $30 billion. This inclues submarines with average displacements of 1,700 tons, including the allowance of 50 tons for defensive systems, with considerable potential for growth in mission duration, propulsion systems, and the like. The $30 billion also includes full cost of operation for 10 years. A lower-cost system could be obtained by deploying the SUM-

SUM retains the major desirable characteristics of the current ICBM force and therefore preserves a healthy diversity in the U.S. strategic deterrent.

MX with 14 warheads (saving about $6 billion), choosing a submarine with less growth potential, and building only 2 bases. SUM will not only be less vulnerable, less obtrusive, and less threatening to arms control but less costly as well.

Charge: *SUM would have no advantage relative to the Trident force. It would mean abandoning the triad in favor of a less desirable dyad and, by putting too much of our deterrent at sea, making it potentially vulnerable to the possibility that the "oceans will become transparent."*

There are major differences, both technical and operational, between SUM and Trident with respect to antisubmarine warfare. Operational advantages include the very much larger number (55) of SUM boats at sea, which gives SUM a major edge against any attempt at continuous trailing of the entire force. Moreover, SUM's proximity to U.S. shores would not concede a benign operating environment to Soviet antisubmarine forces; U.S. naval assets could obviously be used more extensively and aggressively. Physical advantages of the SUM boats include their relative silence (because of electric-drive propulsion) and their much smaller size (displacing 1,700 tons, as opposed to the 18,000 tons by the nuclear-powered boats). On the other hand,the Trident submarines have the advantage of a much larger operating area—17 million square miles as opposed to 1 million—and they don't have to snorkel.

The near-coastal waters of the SUM deployment are a complex operating medium for antisubmarine warfare, which relies, at present, almost entirely on acoustics. Much of these waters are acoustically "shallow": they do not support long-range propagation of low-frequency sonar without loss of signal from repeated bounces off the ocean bottom. Moreover, the SUM deployment area can readily be filled with decoys and noise by generators, making the quiet submarines even more difficult to find (although submerged diesel-electric submarines are regarded as virtually impossible to detect).

However, diesel-electric submarines are relatively noisy while snorkeling to recharge their batteries, and they may also be viewed by radar while at the surface. This raises the possibility that a fraction of the SUM force could be vulnerable to future Soviet antisubmarine capabilities. If it should emerge as a threat to SUM, this concern could be addressed by eliminating the need to snorkel—converting to fuel cells for submarine propulsion. This option should be available in the mid-1990s and could be implemented as individual boats are overhauled.

Both Trident and SUM will be highly survivable for the foreseeable future. In an era in which "stealth" technology is supposed to render our aircraft unobservable to radar, it is certain that analogous techniques could help hide submarines. Vice-Admiral Charles H. Griffiths, commander of the U.S. Submarine Force, recently commented that the oceans are a great place to hide because "they're becoming more opaque as we understand more about them."

A specific advantage of SUM relative to Trident for limited strike options is that the launch of 1 MX missile exposes the location of only 1 additional missile on the same boat, as opposed to 23 for a Trident boat. Similarly, in the planned MX-MPS deployment of a single MX missile in a 23-shelter complex, the launch of each missile reduces by 23 the number of reliable, effective Soviet RVs required to destroy the remaining MX force.

An advantage of a mixed deployment of SUM and Trident systems is that they have very different characteristics, including operating areas and numbers of ships. Hence, Soviet antisubmarine efforts could not be concentrated against one or the other alone, and together they preserve an important diversity for the U.S. deterrent forces.

The United State could soon lose an element of this diversity in its strategic forces as a result of the growing vulnerability of fixed land-based ICBMs. By moving to the drag strip, the United States would be deploying a system with great and unavoidable operational problems. The SUM system, on the other hand, would present only a modest technical challenge and maintain security on the basis of mobility and relatively simple operational procedures at sea.

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THE LEADING EDGE

#1 in a series of reports on new technology from Xerox

About a year ago, Xerox introduced the Ethernet network—a pioneering new development that makes it possible to link different office machines into a single network that's reliable, flexible and easily expandable.

The following are some notes explaining the technological underpinnings of this development. They are contributed by Xerox research scientist David Boggs.

The Ethernet system was designed to meet several rather ambitious objectives.

First, it had to allow many users within a given organization to access the same data. Next, it had to allow the organization the economies that come from resource sharing; that is, if several people could share the same information processing equipment, it would cut down on the amount and expense of hardware needed. In addition, the resulting network had to be flexible; users had to be able to change components easily so the network could grow smoothly as new capability was needed. Finally, it had to have maximum reliability—a system based on the notion of shared information would look pretty silly if users couldn't get at the information because the network was broken.

Collision Detection

The Ethernet network uses a coaxial cable to connect various pieces of information equipment. Information travels over the cable in packets which are sent from one machine to another.

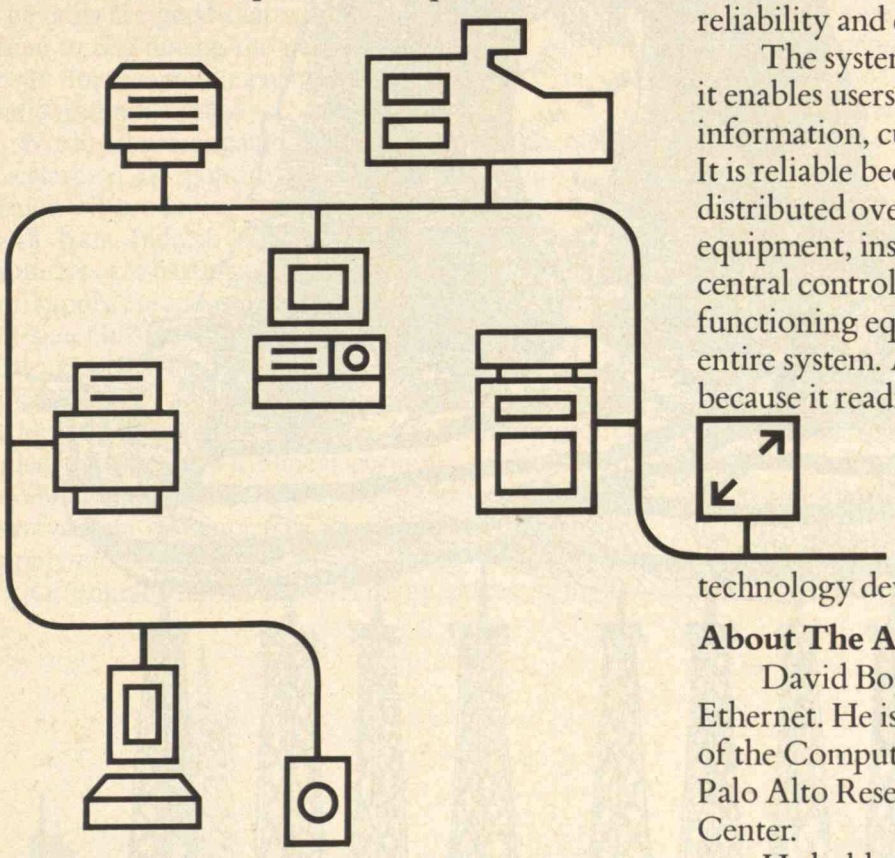
A key problem in any system of this type is how to control access to the cable: what are the rules determining when a piece of equipment can talk? Ethernet's method resembles the unwritten rules used by people at a party to decide who gets to tell the next story.

While someone is speaking, everyone else waits. When the current speaker stops, those who want to say something pause, and then launch into their speeches. If they *collide* with each other (hear someone else talking, too), they all stop and wait to start up again. Eventually one pauses the shortest time and starts talking so soon that everyone else hears him and waits.

When a piece of equipment wants to use the Ethernet cable, it listens first to hear if any other station is talking. When it hears silence on the cable, the station starts talking, but it also listens. If it hears other stations sending too, it stops, as do the other stations. Then it waits a

random amount of time, on the order of microseconds, and tries again. The more times a station collides, the longer, on the average, it waits before trying again.

In the technical literature, this technique is called carrier-sense multiple-access with collision detection. It is a modification of a method developed by researchers at the University of Hawaii and further refined by my colleague Dr. Robert Metcalfe. As long as the interval during which stations elbow each other for control of the cable is short relative to the interval during which the winner uses the cable, it is very efficient. Just as important, it requires no central



control—there is no distinguished station to break or become overloaded.

The System

With the foregoing problems solved, Ethernet was ready for introduction. It consists of a few relatively simple components:

Ether. This is the cable referred to earlier. Since it consists of just copper and plastic, its reliability is high and its cost is low.

Transceivers. These are small boxes that insert and extract bits of information as they pass by on the cable.

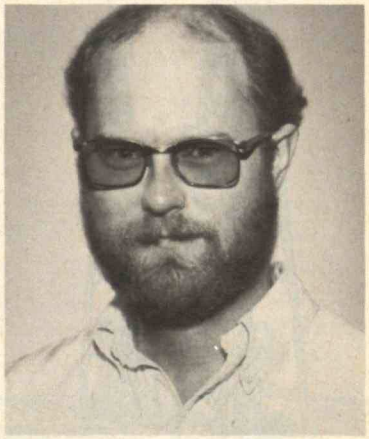
Controllers. These are large scale integrated circuit chips which enable all sorts of equipment, from communicating typewriters to mainframe computers, regardless of the manufacturer, to connect to the Ethernet.

The resulting system is not only fast (transmitting millions of bits of information per second), it's essentially modular in design. It's largely because of this modularity that Ethernet succeeds in meeting its objectives of economy, reliability and expandability.

The system is economical simply because it enables users to share both equipment and information, cutting down on hardware costs. It is reliable because control of the system is distributed over many pieces of communicating equipment, instead of being vested in a single central controller where a single piece of malfunctioning equipment can immobilize an entire system. And Ethernet is expandable because it readily accepts new pieces of information processing equipment. This enables an organization to plug in new machines gradually, as its needs dictate, or as technology develops new and better ones.

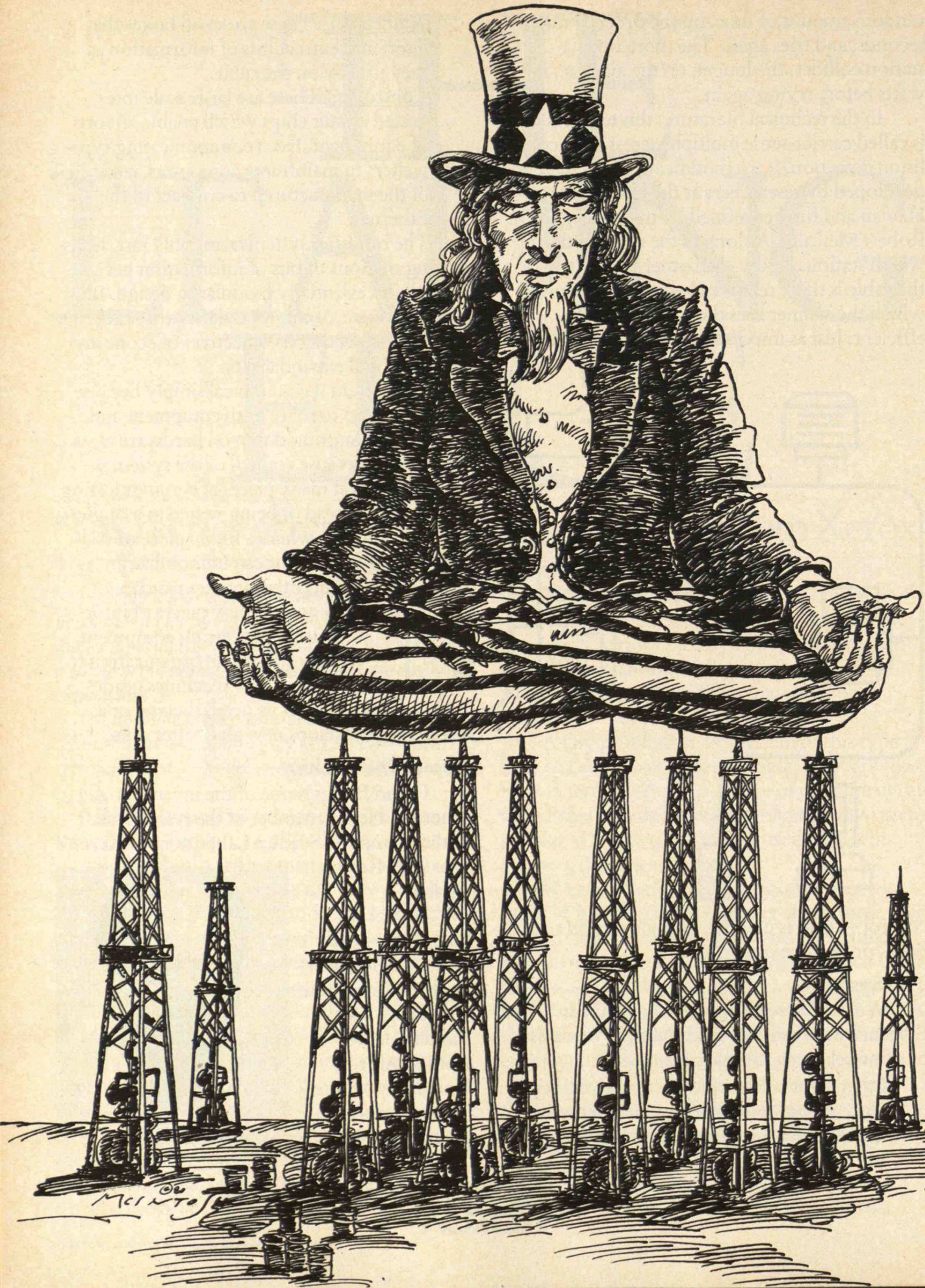
About The Author

David Boggs is one of the inventors of Ethernet. He is a member of the research staff of the Computer Science Laboratory at Xerox's Palo Alto Research Center.



He holds a Bachelor's degree in Electrical Engineering from Princeton University and a Master's degree from Stanford University, where he is currently pursuing a Ph.D.

XEROX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Rising oil prices
don't have to threaten the economic prosperity
of the industrial nations if they adopt
the right policies.

Oil Shocks and Western Equilibrium

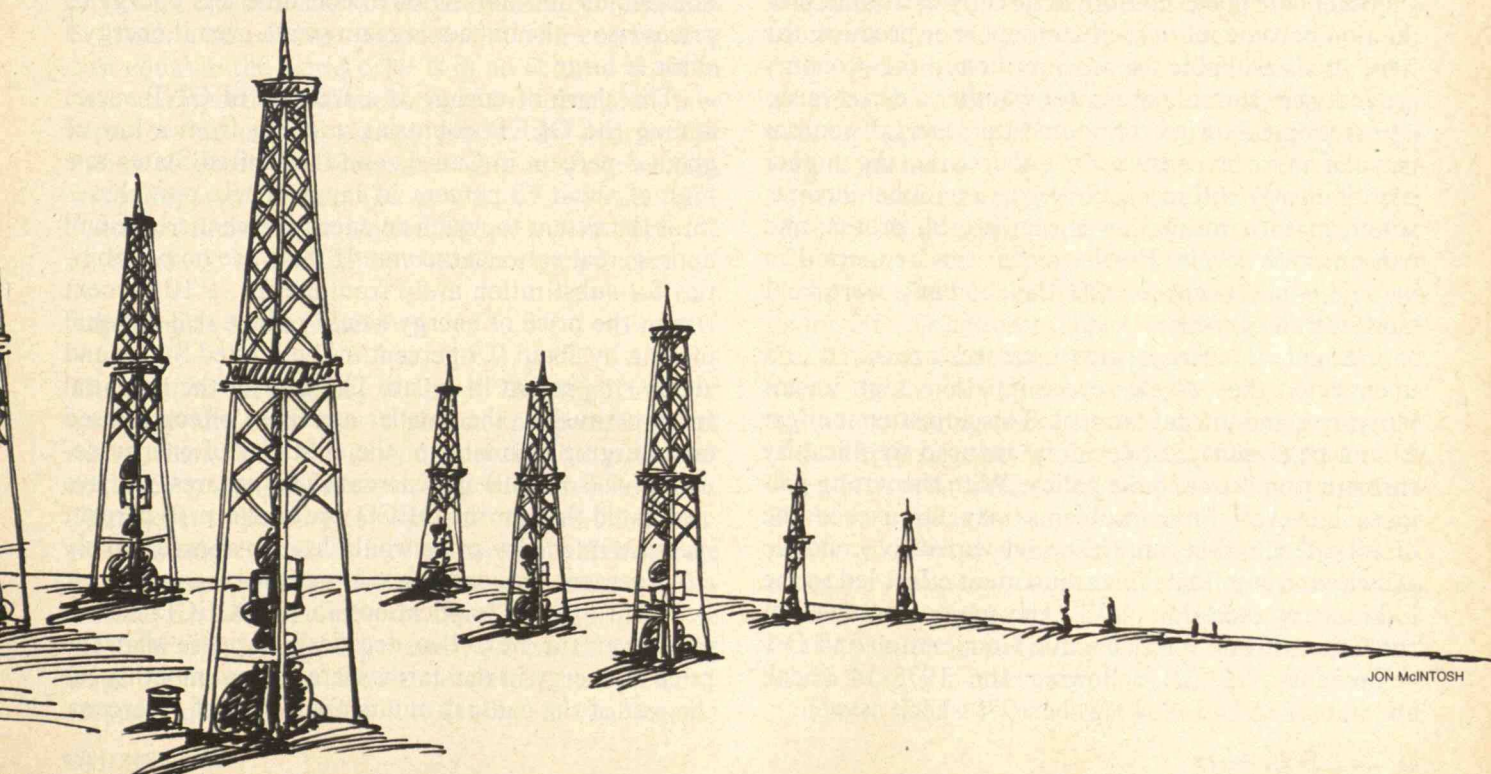
by Robert E. Hall and Robert S. Pindyck

ENERGY prices rose dramatically in the 1970s, contributing to the chronic problems of inflation and economic stagnation plaguing so many countries. The odds are good that world energy prices will continue to rise during the next 20 years. What will this mean for economic policy and performance in the industrial nations?

World oil prices could be sharply and unexpectedly accelerated by political turbulence in some of the major oil-producing countries, as we saw recently with Iran. Indeed, none of the major oil-exporting countries are bastions of stability, and the possibilities for supply cutoffs are numerous. Any country in the Persian Gulf, including Saudi Arabia, may face political upheaval that could reduce or even terminate its production of oil. While the likelihood of another Mideast war has decreased, this possibility cannot be ruled out and would almost certainly lead to major production cutbacks by Arab exporters. Military intervention by major powers could likewise lead to a supply cutoff.

Of course, the future of energy prices is highly uncertain, in part because of the inherent instability of the world oil market. It is conceivable, for example, that the world price of oil could *fall* in real terms over the next 20 years, or rise only slowly. From 1974 to 1978, the economic objective of maximizing long-run revenue seemed to dominate the setting of OPEC prices, and recent analysis indicates that a return to such a policy over the next two decades could lead to real oil prices lower than today's levels. Or the OPEC cartel could break apart, leading to competitive oil prices well below current prices. Also, major new reserve discoveries and unexpected production increases in countries such as Mexico could help to push down oil prices.

But all in all, industrialized countries must be prepared to face further increases in oil prices, and thus increases in the cost of energy in general. These increases may be gradual, but more likely they will be sharp and unexpected as in 1974 and 1979. The consequences can be severe, particularly if the shocks occur when these countries are already suffering from serious problems of inflation, unemployment, and



JON McINTOSH

reduced economic growth. Do rising prices necessarily imply an era of sharply reduced economic growth, greater unemployment, and increased inflation? Does it mean serious balance-of-payments problems for the oil-importing countries, and will it lead to destabilization of the international monetary system?

The answers to these questions depend largely on the kinds of economic and energy policies the industrialized countries adopt, both now and in response to future price shocks. With the proper policies, the impact of future energy price increases will be significant but far from catastrophic. Indeed, the challenge facing the industrial nations during the next two decades will be to absorb the necessary costs of rising energy prices without incurring additional unnecessary costs. If they can meet this challenge, energy prices will not threaten their economic prosperity.

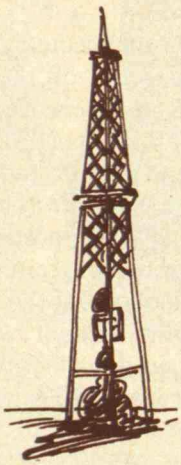
Direct and Indirect Effects

Rising energy prices have two distinct effects on an industrial economy. First, they reduce the total real national income available for domestic consumption and investment. When energy consumers pay more in real terms to foreign energy producers, their real incomes must fall; even the best economic policy cannot change this.

Whenever goods consumed directly or used in production become more costly to import or produce, the total goods available for consumption in the economy are reduced. It does not matter whether a cartel raises its monopoly price or domestic energy sources become more expensive. In either case, the higher cost of energy will mean a lower real national income, which in turn means lower real wages, profits, and consumption levels. Furthermore, this reduction in income would occur even if the economy were kept close to full capacity.

Second, if energy price increases are rapid and unexpected they create severe inflation, high unemployment, and low investment. This adjustment effect cannot be eliminated but can be reduced significantly through proper economic policy. With the wrong policies, however, these problems may far exceed the direct effect and become a serious threat to economic growth and stability. This adjustment effect led to the inflationary recessions in all the major countries of the Organization for Economic Cooperation and Development (OECD) following the 1973-74 shock and appear to be following the 1979 shock as well.

Adjustment problems occur because most modern economies exhibit rigidities in prices, the use of inputs to production, and wages. For example, prices of goods other than energy do not fall rapidly to reflect changes in relative scarcity, and industries cannot quickly shift inputs to production in response to new energy prices. Perhaps most important, real wage rates often fail to fall quickly to the lower equilibrium level consistent with higher energy prices and reduced national income. Labor prices itself out of the market, and full employment becomes uneconomical.



Loss in Real Income

If energy prices rise slowly and steadily, the effect is to depress the level and growth rate of real national income. The size of this effect depends on the role of energy in the economy, both as a fraction of GNP and the ability of consumers and producers to conserve energy when it becomes more expensive. If the share of energy as a fraction of GNP is very small, then even a large price increase will have only a small effect on real income. Alternatively, if the demand for energy is highly price-elastic—if it is easy for households and industries to consume less energy as prices rise—the impact is again small, even if energy's share is large.

The share of energy as a fraction of GNP varies among the OECD countries, ranging from a low of about 8 percent in Canada and the United States to a high of about 10 percent in Japan. These cost shares limit the extent to which an energy price increase will depress real national income. If there are no possibilities for substitution away from energy, a 10 percent rise in the price of energy would reduce real national income by about 0.9 percent in the United States and about 1.1 percent in Japan. The greater the potential for substitution, the smaller are these effects. Based on emerging estimates of the elasticity of energy demand (-0.6 overall) and current energy shares, we have calculated that for the OECD as a whole, a 10 percent increase in energy price would lead to approximately a 0.8 percent reduction in real national income.

What are the implications for the OECD economies over the next two decades? Suppose that the price of energy in real terms were to rise smoothly for the rest of the century at an annual rate of 5 percent.

The most important component of energy policy is the permanent elimination of price controls.

Oil would sell for nearly $100 per barrel in today's dollars in the year 2000—a price that many view as a "backstop" at which oil could be economically replaced by nonconventional energy sources.

Over the next two decades, this hypothetical 5 percent annual increase in energy prices would depress real national income growth in the OECD by about 0.4 percent per year, a 10 percent reduction in the projected 4 percent annual growth rate. Real national income would still rise at an annual rate of around 3.6 percent, although large variations would result from differences in productivity growth and accumulations of savings and capital.

Losses in real income brought about by expensive energy will add to social tensions everywhere, particularly in the United States and Britain, where the loss of 0.4 percent per year in real income growth would constitute a far larger fraction of total growth than in the OECD as a whole. But overall, the loss should be manageable. Of course, this assumes a world free from surprises relating to energy or anything else.

The situation may be more favorable in countries with domestic energy resources. In nations that produce their own energy at very low cost, rising world price of energy would have little direct effect, and nations that export energy produced at low cost will benefit from the shifts in the terms of trade. Among the OECD countries, only Britain and Norway are anywhere close to this favorable position. On the other hand, a nation that produces its own energy at a cost equal to the world price is in no better a position than an importing nation, because the labor and other resources devoted to energy production deprive the nation of goods and services exactly as if the energy were imported. Thus, the production of expensive synthetic fuels in the United States will not provide an economic buffer against rising energy prices.

Adjusting to Price Shocks

The painful experiences of the 1970s taught us that energy prices may rise in sharp, unexpected jumps rather than along the smooth, predictable path that could be accommodated without serious dislocation. Therefore, to prepare to cope with future oil shocks, we must understand the mechanisms by which a sharp jump in energy prices destablizes an economy.

The first effect, likely to be a major problem in most OECD nations, is generally a burst of price and wage inflation. Less well-appreciated, but in many respects more costly, is the decline in real output growth that typically results from the price shock and that may last for a number of years.

There is no fundamental economic law stating that prices in general must rise when the relative price of one commodity rises. Prices of other commodities could just as well fall, and would if there were no rigidities and equilibrium could easily be restored. But experiences of the 1970s revealed that not only do other prices fail to fall when energy becomes relatively more expensive, but they actually rise in most countries. This reinforcing of energy price shocks by sympathetic increases in other prices is one of the most serious obstacles to smooth adjustment.

For example, inflation would have increased by only 2 to 4 percent from 1973 to 1975 had the effects of energy shock been limited to direct increases in production costs and the prices of energy consumed directly. However, the energy shock also induced increases in wages and other nonenergy costs. As a result, almost every major OECD nation had inflation far in excess of 2 to 4 percent. Among the seven major OECD nations, only Germany kept inflation within the benchmark—its rate rose from 6 percent in 1970 to 1973 to only 6.5 percent from 1973 to 1975. The United States was close with 5.1 extra percentage points. Inflation jumped by 6.3 points in Canada and France, 9.2 in Japan, 11.5 in Italy, and 12.7 in Britain. (Figures for inflation are based on the implicit consumption deflator, more uniformly defined among countries than the cost-of-living index.)

A predominant factor in the conversion of an energy price shock into general inflation is wages. Most advanced economies have difficulty making the necessary adjustment to the lower real wage rate necessitated by higher energy prices. The problem is simple: workers would rather not hear that real wages must fall. Again, the example of 1973 to 1975 is particularly instructive. Wage inflation worsened in every major OECD nation except Germany. The acceleration of wage rates was relatively mild in the United States—wage inflation worsened by only 1.9 percentage points during that period. Japan saw an increase of 4.7 percentage points; in Canada, France, and Italy, wage inflation accelerated by 5 to 10 percent; and Britain's wage inflation worsened by 10.1 percentage points. Explicit and implicit mechanisms that automatically link wages to prices create this unfortunate upward pressure on wages. The problem is worsened by the practice of indexing wages to the cost of living, which results in a severe inflationary spiral.

From 1973 to 1975, only Germany escaped this

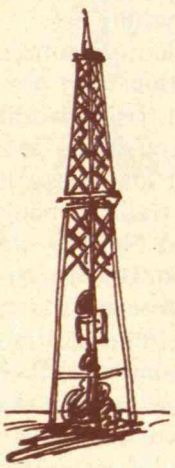
price-wage spiral, which was severe in the United States, Canada, and France and even worse in Japan, Italy, and Britain. This illustrates an important principle: there is no immutable relationship between dependence on imported energy and domestic inflationary effects of a world energy shock. From 1973 to 1975, Germany, heavily dependent on imported energy, had by far the least worsening of inflation, while the United States, the least dependent, was in the middle and the other important OECD energy producer, Britain, had the worst experience.

Energy and Real Output

An energy price shock will affect real output, substantially impeding GNP growth for several years. The major OECD economies experienced more or less synchronous recessions in 1975, and the prospects for similar contractions in 1980 to 1981 are strong. The total economic cost of the recession created by the adjustment to suddenly higher energy prices may be as large, or even larger, than the cost of the higher energy prices themselves over the indefinite future, even though the recession lasts only a few years.

The real output level of modern industrial economies is vulnerable to energy price shocks for a number of reasons. Foremost is the inability of an economy to return to equilibrium quickly at a new—and lower—real wage level. Higher real wages mean that employment will fall after a shock as firms lay off workers rather than take losses, and this will mean a drop in real output. Furthermore, sudden changes in input prices create uncertainty about the profitability of private investment. Together with the high interest rates that accompany a suddenly higher price level, this can produce a slowdown in investment demand. Consumption demand will also fall immediately and permanently because of depressed expectations about future real incomes. In the longer run, export demand from energy producers should offset declines in domestic demand, but the experience of the 1970s showed that this process takes quite some time.

Because of the strong interactions among the major OECD economies, the recessionary impact of an energy shock within any single economy is substantially larger than a purely domestic shock of the same magnitude. The business cycles of the OECD nations were out of synchrony before the 1970s, and when the German economy contracted in 1966, it was saved from deeper recession by the booming U.S. economy. By contrast, from 1973 to 1975, all the major OECD economies went into recession in a strikingly uniform way. Neither the magnitude of the inflationary burst set off by the energy price shock nor the degree of dependence on imported oil entirely explains the reduction in real GNP growth in each economy. The mildest recession was in France, where real GNP growth dropped from 5.5 percent from 1970 to 1973 to 1.8 percent from 1973 to 1975, a decline of 3.7 percentage points. Germany dropped by 4.7 percentage points even though it escaped the inflationary explosion in France and elsewhere. The United States had close to the worst recession, losing 5.9 percentage points of real growth and experiencing a contraction in GNP, in spite of its relatively favorable inflation rates and energy endowments. Because of the tight linkage of the OECD through mutual trade, future energy shocks will have relatively uniform effects on the GNP of all OECD nations.



Monetary Moderation and Fiscal Restraint

Sharp increases in the price of energy create a serious dilemma for economic policymakers. The resulting combination of higher inflation, higher unemployment, and lower real output is the worst of all possible worlds. The only effective policy tool for controlling inflation in the longer run is stabilization of the money supply. On the other hand, monetary expansion, or "accommodation," is one of the more effective ways to offset the impact of the shock on employment and real GNP. However, raising the rate of growth of the money supply seems only an academic possibility in countries determined to limit the excessive inflation of the past 15 years. From 1973 to 1975, monetary acceleration took place only in Canada and Italy, and even there it was very modest.

On the other hand, several OECD nations severely curtailed monetary growth from 1973 to 1975 in an effort to offset the inflationary effect of the energy shock. The most extreme case was Britain, where growth of the money supply fell an astonishing 13 percentage points from 1973 to 1975 from its 1970-to-1973 average. Japan also drastically applied the monetary brakes. Significantly, the country with the

A payroll or commodity tax cut is the natural antidote to an energy price increase.

smallest increase in inflation, Germany, did not reduce (or increase) its rates of money growth; it simply maintained a policy of moderate money growth. The conclusion is that monetary policy should be smooth and predictable to provide a stable economic environment, and should not be used to offset the inflationary effect of an energy shock.

Fiscal policy presents another dilemma in the aftermath of an energy shock. On the one hand, there is pressure to lower individual tax rates to make up for the loss in real income brought about by higher energy prices. But even without tax cuts, government revenues decline in real terms because higher prices for imported energy, combined with diminished levels of economic activity, will reduce the real tax base. There may also be pressure on government to spend more to stimulate demand and counteract recession.

Higher government deficits are likely to follow an energy shock for a number of years and do not by themselves present any serious economic problems. However, fiscal policymakers should recognize that higher energy prices will decrease real national income. It is impossible to maintain real growth in government expenditures *and* cut taxes enough to maintain real growth in consumption when the total resources available for domestic purposes have been reduced by higher energy prices. Although budget deficits are sensible during the recession that immediately follows an energy shock, the growth of revenues must be large enough so that it eventually finances the growth of expenditures. If the government chooses to keep expenditures in real terms at preshock levels, then tax *increases*, not decreases, will be needed sooner or later. With constant tax rates, government expenditures must share in the decrease in real national income. Thus, any increases in expenditures and reductions in taxes that follow an energy price shock should be small and temporary.

Policy Prescriptions for a Price Shock

Although it is impossible to eliminate the inflationary and recessionary impact of an energy price shock, four economic policies can ameliorate that impact. First, governments should not respond to energy price shocks in a knee-jerk fashion by sharply contracting monetary and fiscal policy to prevent the inevitable inflationary burst. Unfortunately, this happened in 1974 and is one of the reasons that many countries experienced such deep recessions in 1975. Some additional inflation is unavoidable in the aftermath of an energy price shock, and severe monetary contractions will only reduce GNP and employment while having little effect on inflation.

Second, when real income falls after a price shock, it is important that the tendency to increase government spending be avoided. The size of the government's share in GNP should be determined by broad social and economic considerations, and reductions in real national income should be spread evenly across all sectors of the economy, including the government. Otherwise government budget deficits can grow out of control, leading to still further inflation and a more than proportionate drop in real income outside the government sector. In countries with substantial domestic energy production, higher energy prices may greatly increase government revenue either through direct income from nationalized energy production or through increased tax revenues from private producers. These revenues should be used to reduce other taxes, not swell government's role in the economy.

Third, special temporary incentives should be used to stimulate investment in the aftermath of an energy price shock because sharp energy price increases can seriously depress investment demand, retarding GNP growth for years. Investment credits, accelerated depreciation, and their equivalents are a good way to stimulate short-term investment in a socially effective way. In the longer term, policies that encourage investment also offset inflation somewhat by adding to productive capacity and thus increasing aggregate supply.

Fourth are cost-reducing tax policies, which operate to lower prices and raise output by reducing the costs of production. In effect, they introduce the short-run flexibility that modern economies seem to lack and are ideal for offsetting higher energy prices and the resulting recessions. However, effective options for cost reductions are limited.

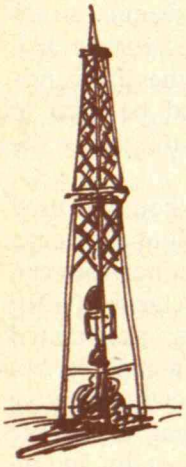
Reductions in payroll and value-added taxes are the leading candidates. Their effectiveness has been demonstrated in reverse by the recent British experience of *raising* indirect taxes just before the 1979 energy shock (undertaken with the laudable objective of lowering income taxes). An increase in payroll or commodity taxes has the same effect as an energy price increase—a price-wage spiral—and much of Britain's current high inflation is attributable to this action. Thus, a payroll or commodity tax *cut* is the natural

The challenge facing the industrial nations will be to absorb only the necessary costs of rising energy prices.

antidote for an energy price increase.

Unfortunately, such a tax cut is limited by the size of existing taxes and requires difficult and extensive modifications in fiscal institutions in many countries. This is especially true in the United States, where the only federal tax of this type, the Social Security payroll tax, is earmarked for a single purpose.

In summary, increased inflation and reduced levels of real income and output are inevitable after an energy price shock, but economic policies can soften the blow. Such policies should include moderate growth in the money supply, restraint on government spending and budget deficits, investment incentives, and, where possible, reductions in payroll and commodity taxes.



Preventing Energy Shortages

Major energy shortages can have a much more severe impact on an industrial economy than large increases in energy prices. By restricting the production of other goods and creating supply bottlenecks throughout the economy, energy shortages can cause considerable economic damage. Would sharp cuts in OPEC production lead to significant shortages?

Barring a major war with widespread disruption of oil shipments, shortages are almost impossible in the world oil market. As long as *some* oil is being produced, any country can import as much as desired by offering a high-enough price. Indeed, the very function of the world oil market, particularly the spot market, is to let prices equalize supply and demand.

Likewise, it is impossible for an oil embargo by the Arab (or any other) members of OPEC to cause an energy shortage. The oil-producing countries can determine the quantity of oil they produce, but they cannot dictate where that oil will ultimately be shipped, so an embargo cannot be effective against any single country or group of countries. The Arab oil embargo against the United States and the Netherlands from 1973 to 1974 had virtually no impact on those countries' imports. Although an embargo may achieve political objectives, it results only in production cutbacks and reduces the oil available to all importing countries. Importing countries then compete for supplies, driving up the price of available oil until demand falls. The problem arises from the sharp increase in prices, not from the possibility that oil might be unavailable.

Even though shortages have not occurred in the world market and are unlikely, shortages at the *retail* purchase level are a distinct possibility. The United States has had the worst experience by far of all the major OECD nations, with serious gasoline lines in many parts of the country both in 1974 and 1979; minor shortages have also occurred in Canada and Britain. The other major OECD countries escaped this problem, even though some are far more dependent on imports than the countries that experienced shortages.

Retail shortages result from government attempts to hold fuel prices below market-clearing levels. Government involvement per se does not create shortages—for example, the government of France is much more involved in petroleum refining and distribution than the United States. But government price controls inevitably lead to shortages. Such controls, combined with government misallocation of regional supplies, created the gasoline lines in the United States. In Europe and Japan, where gasoline prices rose to market-clearing levels, no such problems occurred. Similarly, the United States was plagued by natural gas shortages during the 1970s as a result of federal controls on wellhead prices.

The lesson from the American experience is clear. The United States has now removed all price controls on crude oil, and interstate natural gas markets will be largely deregulated by 1985. Unless such controls are revived during periods of rapid increases in energy prices, repetition of shortages is unlikely. The most important component of energy policy, particularly for the United States and Canada, is a commitment to the permanent elimination of price controls on energy markets.

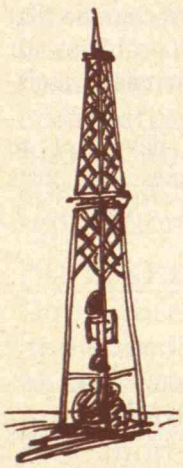
Strategic Reserves

Another important component of energy policy is the implementation of strategic oil reserves. Reserves are not needed to prevent shortages—shortages will not occur in the absence of government controls. But we have seen that sharply rising energy prices cause much more damage than slowly rising ones, and strategic reserves can smooth out price increases in the wake of a major production cutback.

Strategic reserves are most effective when imple-

mented multilaterally. When any country releases its stockpile, it adds to the supply of oil in the *world* market and thereby reduces the world price. If the United States released a stockpile in the wake of a crisis, its imports of oil would fall, but the impact on world oil prices—those faced by American consumers—would be minor. In that case, the benefits of stockpiling might not be worth the cost to the U.S. But if most or all of the major OECD nations maintained large stockpiles of oil that under international agreement flowed into the market during a major production cutback, this would significantly reduce any sharp price increases and resulting economic damage.

Finally, the impact of energy shocks can be reduced through taxation. Energy taxes reduce overall energy dependence, thereby mitigating the potential economic impact of sudden increases in world energy prices, and can be used to help finance reductions in payroll and commodity taxes. Like strategic reserves, energy taxes can be most effective when imposed multilateraly. Just as the OPEC cartel exercised monopoly power by coordinating cutbacks in oil production, so the OECD countries can exercise monopsony power with concerted action to reduce energy demand. Such use of taxes would not only reduce vulnerability to energy price shocks but would also create downward pressure on world energy prices.



The International Financial System

There is a pervasive fear that growing surpluses by the oil-exporting countries—which imply growing trade deficits for the importing countries—impede the recycling of petrodollars and make exporting countries less willing to hold financial assets in lieu of in-ground oil reserves. OPEC and other oil exporters face three possibilities for spending their petroleum revenues.

First, they can purchase goods produced by oil-importing nations. In the aftermath of the 1973-to-1974 oil price increase, OPEC surprised its major customers by rapidly converting payments into goods and services. Second, producers can purchase marketable financial claims upon the oil importers. OPEC members, especially the Arab nations, have accumulated large volumes of U.S. government obligations and other readily marketable financial instruments, and most OECD countries already produce such instruments in large volume. Finally, OPEC can make direct investments in the oil-importing countries.

If their need for imports were limited, OPEC countries would take a good part of the proceeds from the sale of oil in the form of direct investments or financial claims upon other economies, and the importing nations would run large balance-of-trade deficits. This would be a *healthy* accommodation to the circumstances that would not strain the international financial system or individual economies if importing nations recognized that trade deficits were inevitable and desirable.

Unfortunately, there is an irrational tendency in some countries to view trade deficits, even if temporary, as threatening to economic health and stability. This puts pressure on governments to adopt "beggar-thy-neighbor" tariffs and quotas in an attempt to export the deficits to other countries. The result is a useless stifling of world trade and further unnecessary reductions in national incomes.

A second problem arises if oil producers begin to lose faith in the financial obligations of their customers. Currently the OPEC nations are accumulating claims upon the rest of the world (primarily OECD countries) at a rate approaching $100 billion per year. Although this is a small fraction of the growth of financial instruments in OECD markets each year—in 1980 the United States alone will create over $60 billion in further government obligations—OPEC members may well question the wisdom of putting so much wealth in a form susceptible to expropriation.

This would create a bias in favor of taking immediate delivery of goods produced by the OECD, the solution to the first round of oil price increases, or, worse, storing wealth as oil in the ground. The inability of the OECD to guarantee the security of OPEC investments creates an incentive to limit oil production and further raise prices. And resulting higher prices can lead to still further concern about investment security.

Therefore, the threat is not within the international financial system, which can easily provide the assets OPEC wants. Rather, OPEC may decide it does not want assets or goods and so further reduce oil production. Convincing OPEC that financial obligations will be honored should be an important policy of the OECD nations.

We cannot ignore the poorer nations, which will face particularly severe problems from rising energy prices.

Plight of the Developing Countries

Although we have focused on Western industrial economies, we cannot ignore poorer nations. They are likely to face particularly severe problems from rising energy prices, creating both moral and economic problems for industrial nations.

Our analysis of the direct effect of higher energy prices on real income applies with even greater force to the less-developed countries (LDCs). Evidence suggests that LDCs will be less successful than industrial nations in offsetting higher energy costs because their potential for substitution away from energy is smaller. Thus, the reduction in real income growth caused by rising energy prices will be greater and much more significant in countries where a large fraction of the population lives near the margin of subsistence.

A more immediate problem is the LDCs' accumulation of debt to large banks. Energy-dependent nations typically pay for OPEC oil at least in part with financial claims rather than exports of goods and services, particularly following a sharp rise in prices. Because the LDCs do not have readily marketable government or private debt instruments, they are more limited in financing trade deficits.

In the past decade, large banks have acted as intermediaries by providing loans to LDCs and issuing their own reliable instruments in the international credit market. But this process may soon end as the risk of these loans increases. OPEC may invest directly in projects in the LDCs, an activity that has accelerated recently, but this cannot be counted on. As a result, the LDCs cannot run large chronic trade deficits indefinitely. They will be forced to substantially limit oil imports and reduce real output, or they will have to increase exports of commodities and goods. The increase in oil prices in 1973 raised the aggregate account deficit of the non-OPEC LDCs from $10 billion to $35 billion by 1975. This figure fell to $22 billion in 1977 but reached about $70 billion last year. The impact on GNP growth in the LDCs has been limited at the cost of major increases in external indebtedness, which may seriously restrain future GNP growth.

This means that industrial nations should be willing to run large trade deficits so that the LDCs can finance oil imports through exports, but there will also be a need for increased direct aid. We should not expect to depend on the current pattern of extending loans that may never be repaid. Instead, the high-income nations of the OECD must carefully consider and act on the growing disparity in world real income levels, a disparity exacerbated by rising energy prices.

Energy prices are likely to continue to rise in real terms, possibly in sharp and unexpected bursts as in 1974 and 1979. This will no doubt impose significant costs on industrial economies in reduced growth in real income and output and higher rates of inflation and unemployment. In countries with growing political pressures to increase military and social-welfare expenditures while reducing taxes, these costs will be particularly stressful. But these costs should be manageable, even if energy prices triple in real terms over the next two decades. The challenge to industrial economies will be to adopt economic and energy policies to prevent these costs from becoming larger than necessary.

The adjustment to future energy price shocks will be considerably eased if economic policies include moderate money growth, fiscal restraint, investment incentives, and one-shot reductions in payroll and value-added taxes. Multilateral development of strategic reserves and taxes on energy can further ease adjustment. Barring a major war, shortages of oil or other fuels need not occur if energy policies are based on maximum price flexibility rather than artificial price controls. The recycling of petrodollars can also continue smoothly as long as importing countries recognize that temporary trade deficits are inevitable, and they maintain the credibility of their financial obligations. Finally, wealthier nations should recognize that rising energy prices will create special problems for poorer nations, which may require increased assistance.

Unfortunately, most governments have yet to accept these facts and adopt these policies. The costs of further delay may be considerable. □

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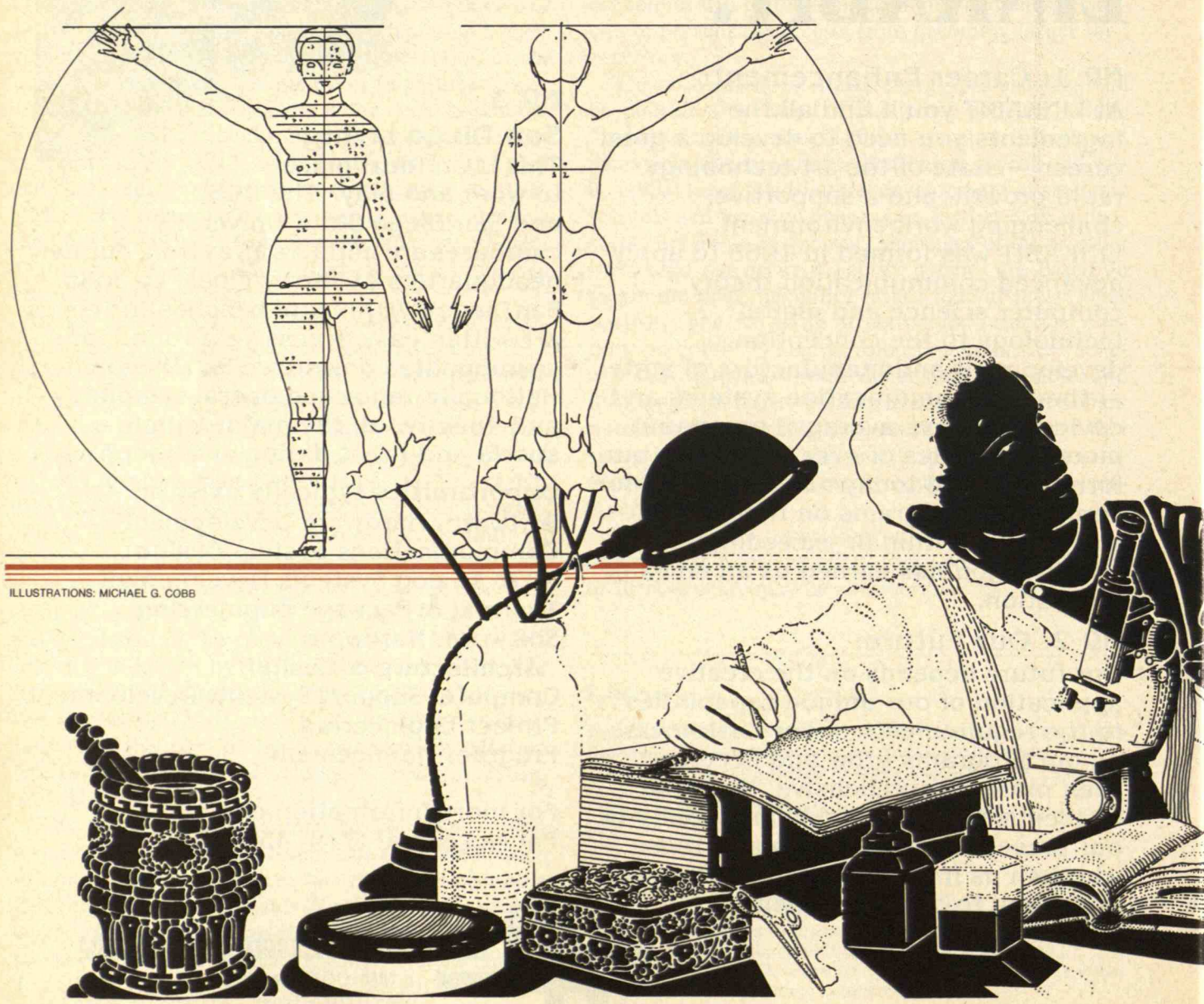
Basic Medical Research: A Long-Term Investment

by Lewis Thomas

We are drawing capital from a bank of information stored long ago that must constantly be replenished.



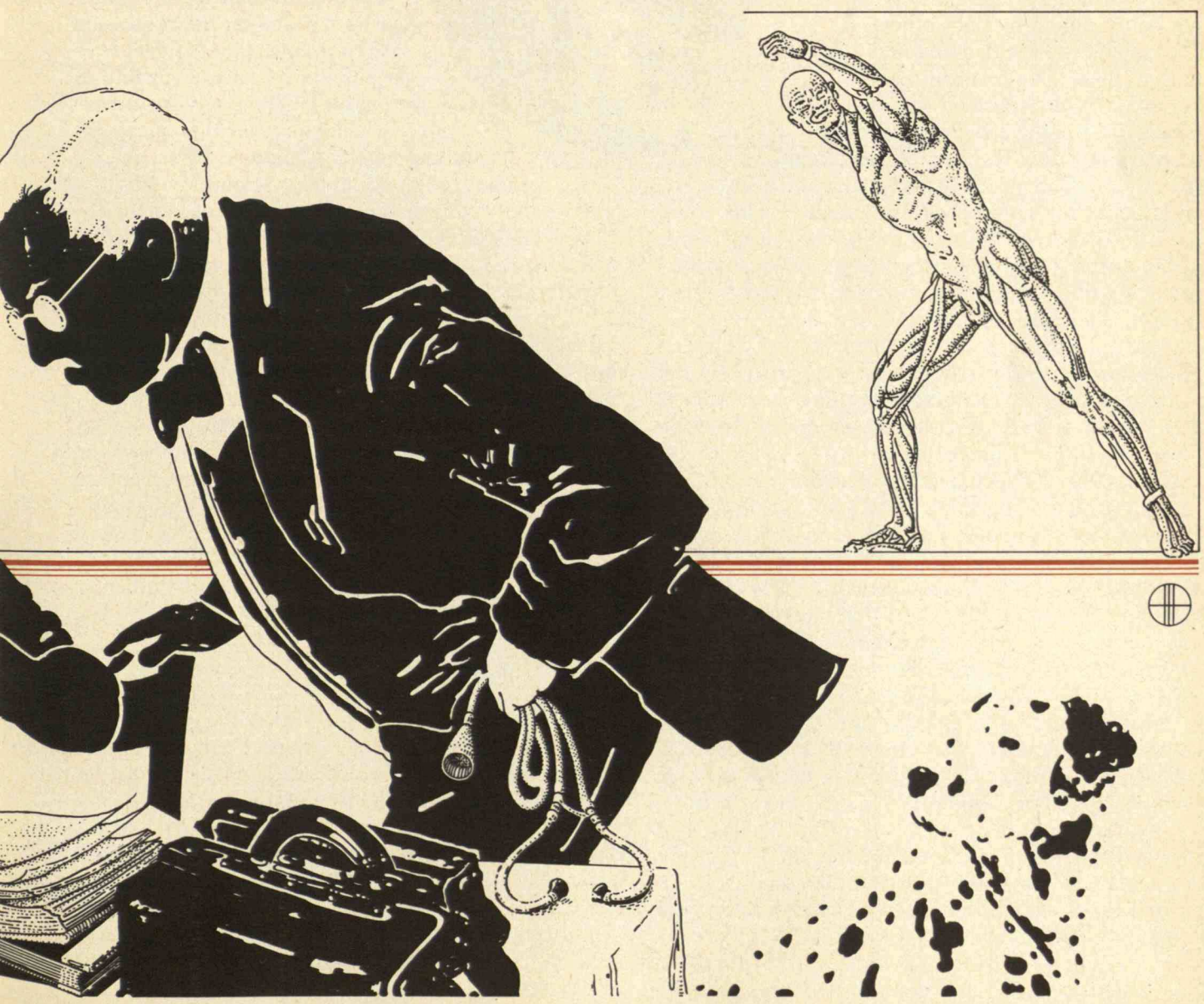
ILLUSTRATIONS: MICHAEL G. COBB

WITHIN my lifetime, medicine has changed a great deal, more than most people realize. Even those who have lived through the period have difficulty recognizing the connections between the old enterprise and the new one. It is as though we gave up altogether one profession labeled medicine and took up a totally new one; it takes a long look backward to see the change.

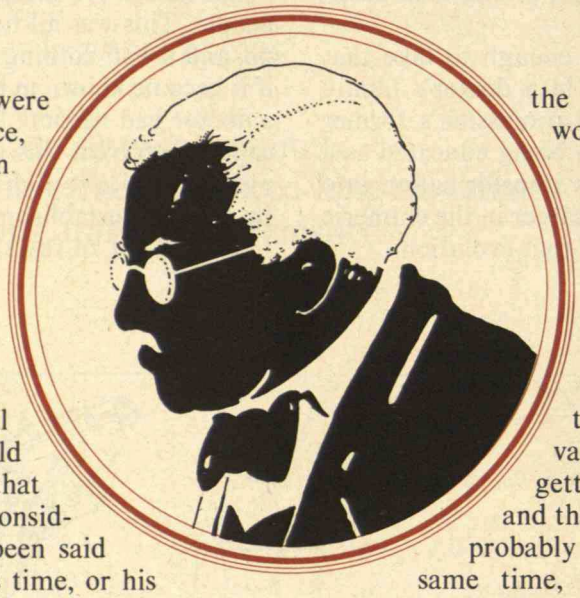
As it happens, I am just old enough to take that sort of view, having grown up in a doctor's family during the final decades of the profession's former existence as an applied art, then being educated as a doctor when medicine began its transformation into a science, and finally pursuing a career in the chimeric profession that was the result of that evolution.

My father was a busy and successful general practitioner for most of his life, becoming a self-trained and self-certified surgeon in his latter years, as was the custom. During all his years in general practice, he possessed only a smidgen of knowledge of science, which he used solely for the purpose of diagnosis. What he did for treating disease was to take care of people. This was all he, or anyone else, knew how to do, and it had nothing to do with technology. Indeed, if it became known in the small town I grew up in that a doctor had become locally famous for his technical capacity to treat this or that disease, the question of medical ethics would have been automatically raised by the local establishment.

This is not to say that treatments for illness were



I do not remember hearing about a suit for malpractice during my father's professional lifetime; the question simply did not arise.



not used by doctors, but they were more like gestures of reassurance, even pats on the head, than pieces of technology. Prescriptions for all kinds of complaints were written in Latin for numberless compounds of great complexity with unknown biological properties, but neither my father nor other doctors of his time had any real faith in them. The best that could be said for the treatments was that they did no harm, which was considerably more than could have been said for the medicine of his father's time, or his grandfather's. I do not ever remember hearing about a suit for malpractice during my father's professional lifetime; the question simply did not arise. Nobody could possibly have been damaged by the therapy available and much less by its omission.

How did it happen that the doctors of my father's generation were so passive, that things that they did were so admittedly ineffectual? I think the answer is that they had been educated at the end of the first revolution in medicine, and a large part of their education had been directed at the abandonment of false information that preceding generations of physicians had taken for granted. For a great many centuries, the technology of therapeutic medicine had been based on something rather like pure guesswork, and anybody's theory stood a good chance of being incorporated into dogma for the generations to follow. What we now consider human experimentation of the most unethical kind was everyday medical practice. In the early nineteenth century, for reasons now beyond comprehension, the removal of a pint or more of blood was believed to be beneficial whenever a patient seemed mortally ill. At the same time, massive doses of powerful purgative, application of blistering agents to the skin, inducement of vomiting, immersion of the body in very hot or very cold baths, and the administration of extracts of every available plant were all accepted measures employed whenever the doctor felt like it. It was taken for granted that medicine, to be effective, had to be a strenuous, perilous sort of enterprise, or the most ordinary kinds of illness would surely prove fatal.

Then, about 150 years ago, the revolution began. Several sagacious physicians here and abroad took a careful look at the treatment of typhoid fever and realized it was doing a lot more harm than good. It gradually dawned on the profession that a great many patients with various illnesses were capable of getting well without any treatment, and that many popular therapies were probably making matters worse. At the same time, genuinely scientific activities were underway. Reliable classifications of human disease were constructed based on clinical observations and correlated with discoveries in the emerging field of pathology. During the latter part of the nineteenth century, the history of disease came to dominate medical education, and the art of making an accurate diagnosis and forecasting the likely outcome of every illness became the highest skill and the indispensible craft of the practicing physician. At the same time, largely under the influence of Sir William Osler and his colleagues, doctors were trained to be skeptical about treating disease. There were a few things they could do, but only a few. Malaria could be treated with quinine, digitalis was used with skill for heart failure, and morphine was the great standby, the most respected of all drugs in the pharmacopoeia.

Artistic License

By the time I arrived in medical school in the mid-1930s, there had been a few more advances: liver extract was used for pernicious anemia, insulin for diabetes, immunization for diphtheria and tetanus, and antiserum for pneumococcal pneumonia, but not much else. I was taught at Harvard Medical School, as my father had been taught at Columbia, that treating disease would be the least of my responsibilities. The doctor's job was to recognize the nature of disease and to explain to the patient and the family what was happening and how it was likely to turn out. This

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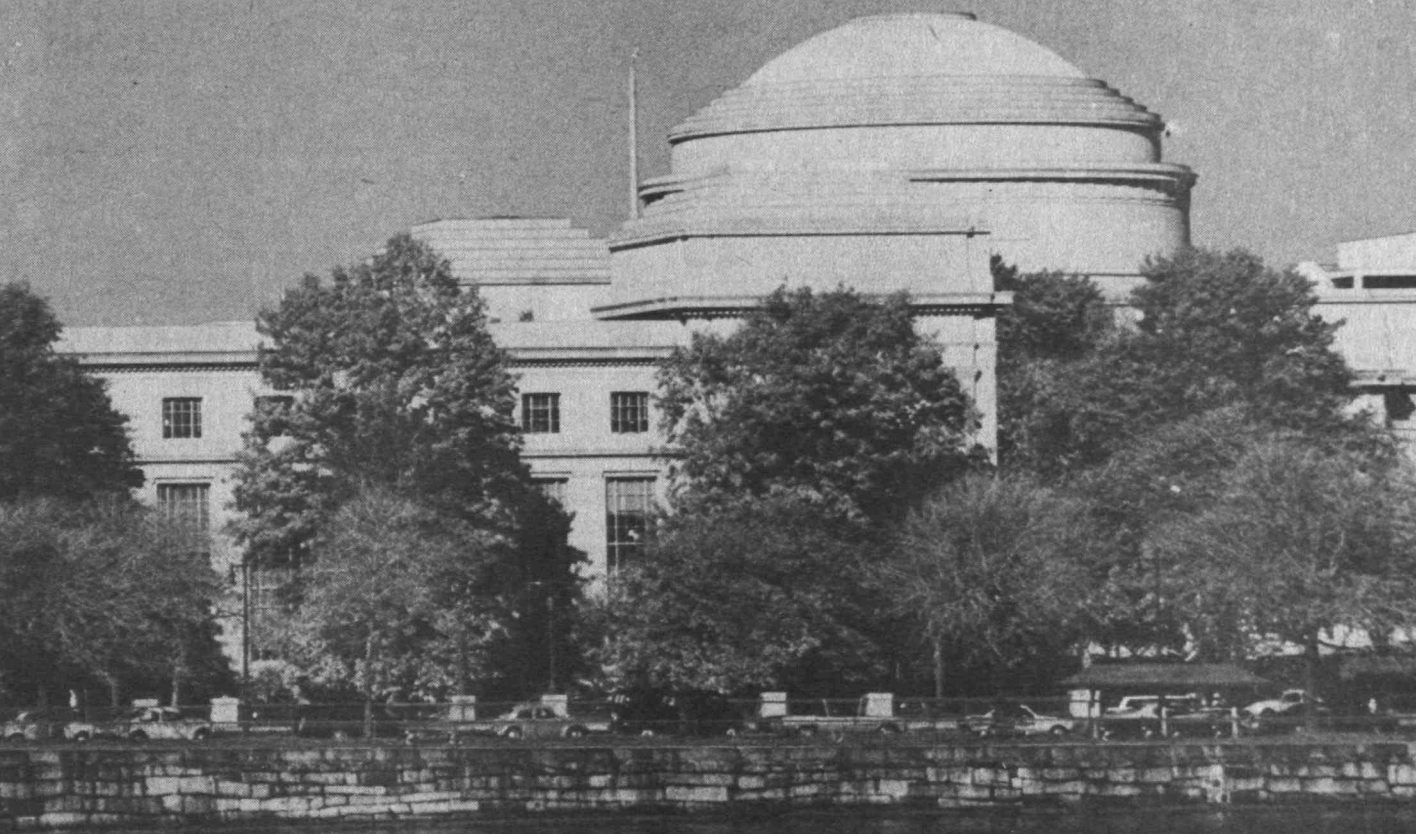


MIT

A Quake in the World of Art: Tremors High on the Richter Scale of Righteousness

by Lester Wolfe, '19

February 27, 1981: It is always interesting to see what our flashing taxi light on the corner of 49th St. and First Ave. entices from the stream of northbound traffic. This time it proved to be a cab piloted by a moonlighting college student.

"Where to, sir?"

"82nd and Fifth, please."

"Ah, the Met!" he said. "My magic carpet to beauty and tranquility—a Persian garden where the most luscious of our big red apples grow."

For the sake of brevity and making my appointment on time, I countered simply with, "Spur your steed, Rustam—I have a one o'clock appointment."

My one o'clock appointment was with Professor Heather Lechtman, director of the Center for Materials Research in Archaeology and Ethnology at M.I.T. Professor Lechtman and I were invited to meet with Maryan Ainsworth, an historian of art who is in charge of the "Rembrandt Project" in the Department of Conservation at the Metropolitan Museum of Art.

Professor Lechtman had heard that the Met was using her neutron activation process for the examination of seventeenth-century Dutch paintings. Little had been done with this technique since she and Edward V. Sayre of the Department of Chemistry at Brookhaven National Laboratory had originated it in connection with Ms. Lechtman's master's thesis at New York University's Institute of Fine Arts in 1965.

I had known Professor Lechtman only a short time, having read with considerable interest her papers dealing with the gilding of metals in pre-Columbian Peru. Here was a remarkable accomplishment by a physicist-archaeologist in a field dear to me.

Like Being in Rembrandt's Studio

Ms. Ainsworth conducted us to a large room in the Museum's Conservation Department. On the walls, illuminated by light boxes, were exhibited groups of large x-ray film negatives. Each group was a contact autoradiograph of a single painting from the museum's precious collection of great Dutch seventeenth-century masters—Van Dyck, Vermeer, Rembrandt. On one group of films one could see the image of a particular set of pigments that the artist had used in the painting. Next to it, on another group of films, was the image of a different set of pigments used in the same painting. One could look at the work of the artist as if one were with him when he first approached the empty canvas and proportioned and sketched in his work. In the case of Rembrandt, his first sketches were in bone black. His brush strokes and their varying pigment loads as he proceeded were evident. Changes in his relative proportions were evident also. His marvelous technique could be studied in detail. In his famous masterpiece "Aristotle Contemplating the Bust of Homer" one could see how he had decided to shorten the height of the pedestal of Homer to improve the proportion. One could also see where restorations had been made to the lower central portion of the painting. The entire effect of this display on both Heather Lechtman and me was overwhelming.

What had induced the Met to expose about $100 million worth of its greatest art treasures to the relentless though harmless scrutiny of neutrons from the Brookhaven reactor? I found the answer to this question the following Monday.

On that morning I found that Ms. Ainsworth had left for Holland to answer a call from Dutch museums interested in applying Professor Lechtman's technique to their collections. So I turned to Ms. Ainsworth's employer, John Brealey. I learned from him that the action started shortly after Mr. Brealey arrived from England in September 1975 to fill his new job at the Met as conservator of paintings. He was asked to clean and restore a Rembrandt which was to be presented to the museum by one of its benefactors. After examining it, Mr. Brealey recognized that it was not authentic and advised that it would be folly to proceed. In his long experience he had never seen a Rembrandt like it.

The musuem authorities were understandably embarrassed, and it was decided to take an x-ray of the painting. The x-ray showed another portrait beneath, but this failed to convince all the people concerned. Mr. Brealey was then the center of great pressure. Lawyers, bankers and auctioneers bore down on him; but to his great credit he stood by his opinion that it was painted by another hand in a later period. Finally he talked the matter over with the museum's physicist, Pieter Meyers, and asked him if he and Edward Sayre at Brookhaven would agree to expose the painting in question—together with one of the Museum's own Rembrandts (as a reference)—to neutron activation and autoradiography in accordance with Heather Lechtman's procedure.

Permission was granted. The paintings were moved to Brookhaven under heavy guard and the exposures were made.

Science in the Service of Art

This neutron activation process as used in the study of oil paintings involves a very mild non-destructive exposure to thermal neutrons, inducing a low, transient radioactivity which is sufficient to expose a photographic film placed in contact with the painting. Since different elements in the pigments used by the artist have different radioactive half-lives, exposures taken at different times during radioactive decay differentiate the pigments of the painting. Interpretation of this series of images permits one

A mosaic of neutron autoradiographs of Rembrandt's "Aristotle Contemplating the Bust of Homer" (Metropolitan Museum of Art). This new technique reveals (extreme left) that as the artist developed the painting he changed the height of the pedestal supporting the bust to improve the proportions. In the neutron activation process developed by Edward V. Sayre of Brookhaven National Laboratory and Professor Heather Lechtman, now of M.I.T., paintings are exposed to neutrons that make elements in their pigments slightly radioactive. Then the radiation from these radioactive elements is captured on films laid on the surface of the paintings. Since each radioactive element has a different characteristic half-life, films exposed to the painting at different times after the neutron exposure show details representing different pigments.

to identify each of the pigments used by the artist and to study his techniques and the painting's structural history.

The long period between Professor Lechtman's graduate thesis and this first important use of autoradiographic technique may be due to the fact that research reactors as a rule do not have large enough irradiation chambers to accommodate an average painting. At Brookhaven, however, a medical unit with a target area designed to accommodate a human figure was available.

The very first films of the proposed gift to the Met showed the presence of a nineteenth-century French painting directly under the "Rembrandt" in question. It was a stunning debut for the new technique, with results which were extremely embarrassing to both the museum authorities and the well-intentioned and very generous benefactor. Rembrandt specialists who had always accepted the attribution now claimed they never thought much of it.

To the credit and everlasting tribute to those responsible for the direction of the Metropolitan Museum of Art, it was decided to turn this remarkable eye of science to the study of its collection of seventeenth-century Dutch paintings. Hence the exhibit which Professor Lechtman and I were invited to see last February 27.

There is no doubt that Heather Lechtman's neutron activation autoradiograpic examination of oil paintings will shake the very foundations of the art world. This is not the first time that advances in science have been used to advantage in the humanities. One need only cite the use of carbon-14 dating in archaeology, x-ray examination in a variety of art forms, infrared examination in general and thermo-luminescent testing in ceramics—to name but a few.

The autoradiographic procedure for the analysis of paintings supplies a remarkable tool for art historians, art museums, and collectors—another triumph in the interaction between science and the humanities.

Pairing Physics and Archaeology into New Insights on Ancient Materials

by Marjorie Lyon

Technology may be said to have begun when ancient peoples first manipulated their natural environment. The extraction of materials from nature and their processing into useful cultural artifacts—whether buildings, tools, irrigation canals, or works of art—is one of the areas of human technological behavior studied by archaeologists in their effort to understand prehistoric society. If, through the study of archaeological artifacts, we can arrive at an appreciation of the ancient systems of technology that produced those artifacts, then we will have made a large step toward understanding an important aspect of social life and behavior in prehistory, explains Professor Heather Lechtman of M.I.T.

Some of these questions can be answered by conventional archaelogical techniques. But archaeologists, typically sophisticated in the social sciences and humanities, often know too little about the materials sciences to be fully sensitive to the technical problems which confronted and were resolved by ancient people—an important dimension whose absence is critical to a full understanding of many ancient cultures.

A National Resource in Ancient Technology

Hence the Center for Materials Research in Archaeology and Ethnology, designed to further a new interdisciplinary approach to the study of archeological material, to train students "to be literate in both the social and physical sciences," says Professor Lechtman. The center, with dual goals of education and research, was established by nine Greater Boston educational, research, and cultural institutions in 1977 under the impetus of Professor Cyril Stanley Smith, '26, who was then Institute Professor in the Departments of Materials Science and Engineering and of Humanities. Professor Lechtman, who had worked closely with Professor Smith in the founding of the center, became its first director and administers the center from its central office at M.I.T.

Professor Lechtman, who also holds a joint appointment in both departments as professor of archaeology and ancient technology, says the center is unique in the U.S. and well on the way to becoming "a national resource for education and research in this new field." Her own work is typical of the interdisciplinary approach she advocates—research on the technological systems devised by ancient Andean peoples to manage the recalcitrant and extremely difficult environment of what is today Peru, Colombia, Ecuador, Argentina, and Chile.

In particular, she is studying the development of metallurgical technologies in the pre-Columbian Andes. She spent considerable time doing field work in Peru, looking for and examining ancient metallurgical sites: early mines, smelting operations, and workshops. From these sites she has recovered metal objects, ore samples, and remains of smelting slags for laboratory analysis at M.I.T.

A Transition From Radiation Physics to Art History

After studying physics and anthropology as an undergraduate, Professor Lechtman spent four years at the Sloan Kettering Institute for Cancer Research in New York, doing research and clinical studies in radiation physics for cancer therapy. But that failed to fulfill her curiosity about anthroplogy, so she returned to the classroom for a new graduate program in the field of fine art conservation (the scientific analysis of materials of which objects are made and of their preservation) at New York University's Institute of Fine Arts.

It was there that she met Edward Sayre, a nuclear chemist at Brookhaven National Laboratory who was also a faculty member of the Conservation Center at the Institute of Fine Arts. Dr. Sayre

had already used neutron activation techniques to analyze such materials as ancient glasses from the Near East. He suggested neutron activation as a way to study the materials and techniques used in oil paintings. Ms. Lechtman had the necessary science background to attempt such a project and Dr. Sayre asked her to join him at Brookhaven to work on this research. Within a year she had devised a successful procedure that was nondestructive to paintings. It became the basis of her master's thesis in 1965, and she found the whole project, she says, "wildy exciting."

But for 15 years the process—though thoroughly proved—was scarcely used. There are reasons: The procedure requires an irradiation chamber of thermal neutrons large enough to activate a painting but few reactors are built to accommodate objects as large as paintings. Futhermore, it is necessary to transport precious objects to the reactor site, and most damage to museum objects occurs in transportation. Convincing a museum curatorial staff to permit its valuable paintings to be activated is yet another obstacle. "Even though my experiments clearly showed that no radiation damage occurs to the paintings, this a stumbling block," says Professor Lechtman.

Autoradiography: How It Works

Thermal neutron bombardment is used to induce a very moderate, nondestructive radioactivation of an oil painting. The temporary radioactivity produced within the painting is sufficient to expose photographic film placed in direct contact with it. The result: a series of autoradiographs that reveal structural details in depth of the painting and its support.

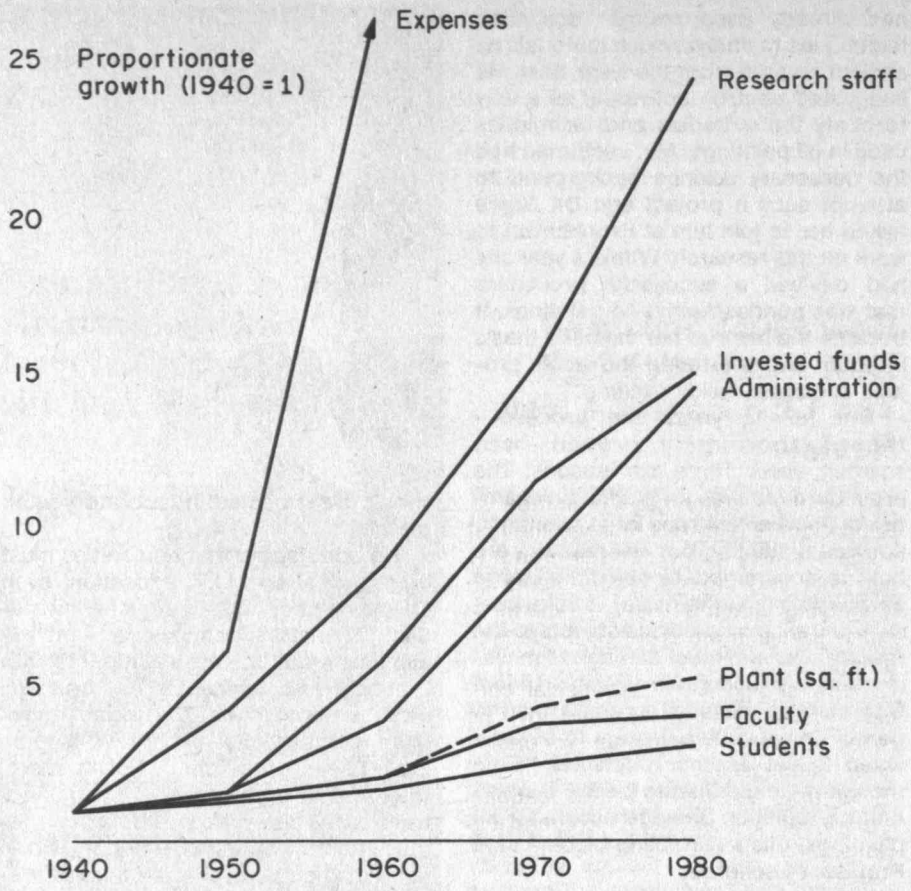
The radioactivity induced by the neutrons in different elements within a painting decays in different manners and rates for each element. By making exposures through appropriate filters and at varying times after the original activation, a series of significantly distinct autoradiographs can be obtained. Their analysis allows the researcher to identify a number of the pigments used in a painting and the manner in which they were originally laid down by the artist.

The Metropolitan Museum's use of neutron activation autoradiography to study its fine collection of Rembrandt paintings is the first major and important utilization of the technique. The results, not possible with any other method, provide art historians with an extremely valuable tool for understanding the artists' techniques and materials. In the Rembrandt case, the autoradiography even shows the original drawings Rembrandt made on the canvases as well as the pigments he used in the paintings.

Although neutron activation autoradiography is not likely to become a routine procedure for examining paintings, undoubtedly certain analytical centers will develop where the work will be carried out. The results of the Metropolitan Museum's project are so exciting that the National Gallery in Washington is considering using the technique on its Dutch masterpieces. The technique is "undoubtedly a major development in the methodology of art historical inquiry," says Professor Lechtman.

Professor Heather Lechtman (left) with students at the Center for Materials Research in Archaeology and Ethnology Graduate teaching laboratory in building 20 at M.I.T. (Photo: Virginia Gunter)

How we've grown in 40 years: a new administrative survey shows that the total academic and research staff has grown from 663 in 1940 to 7,390 in 1980. In the same period, enrollment has gone from 3,056 to 8,910 and the budget from $3.7 million to $418.1 million (far off the scale in the chart).



The Confines of Space: Tight and Growing Tighter

"My research is going to double in the next two years, so I will need an extra 20,000 square feet."

At one time that was a reasonable request. But not any more. "It just isn't that simple," Francis Low, provost, told a faculty meeting last winter. "There is not a large number of 20,000 feet available to go around.

"In the not-too-distant past, research expansion was generally possible and encouraged as a good thing that brought more interest, life and resources to M.I.T.," he said. "But now we're pretty close to the limit; if we expand in one area we will probably have to contract in others." Indeed, he told the faculty, "Scarcity of office and laboratory space must constrain the amount of new research at M.I.T."

Ovadia R. Simha, director of planning, and William R. Dickson, vice-president for operations, elaborated. Over the last 40 years, M.I.T.'s land devoted to education and research has increased at about one acre (or less than one percent) per year, from 100 acres in 1940 to the current 135 acres, Mr. Simha explained. In the meantime, non-student population has grown from 1,400 to 6,400, with the result that M.I.T.'s population density now is much higher than average for universities. Today's problem is compounded by two circumstances from the past, Mr. Simha told the faculty:

☐ Between 1950 and 1979, many of the activities we were involved in required more space per person, and standards of space were more generous during this period. Now we have to face the question of whether we can maintain these standards today. Already, M.I.T. is spending less per square foot in constant dollars than in the past, and "that's the direction that we'll have to continue," Mr. Simha said.

☐ New construction has occurred during the last 40 years in spurts, usually after a major development campaign. As a result, Mr. Simha explained, the major growth that occurred in the 1960s as a result of the Second Century Fund is now coming into its twentieth year; buildings funded in the Mid-Century Campaign of the 1950s are now reaching their thirtieth year. All all of them need the same kind of maintenance at the same time.

Now it's happening all over again. A total of $73 million in new construction is now underway, Mr. Simha said, including a new Carleton Street building for the Whitaker College of Health Sciences, Technology and Management and the Medical Department, a new student residence at 500 Memorial Drive to house 353 students this fall, and renovation of many buildings. In addition, funds are on hand or being sought for other projects totalling some $100 million. These include a classroom and research facility for very-large-scale integrated circuits; a building for the Arts and Media Technology Program on Ames Street, a building for the department of physics, and a brain sciences and psychology building. All this new construction will yield 200,000 net square feet of new space, but most of that will go to new projects and facilities, Mr. Dickson told the faculty. The amount available for relocation of present acitivities will amount to about 80,000 net square feet in comparison with requests totalling more than 200,000 square feet. "Patterns of space utilization must change. We will have to make more effective and intensive use of the space we have," Mr. Dickson said.

From Junkyards to Townhouses

Today's space problems are confounded by the fact that property around M.I.T. has been climbing in value, explained Mr. Simha. Current and planned developments in Kendall Square, including office, retail, commercial, hotel, and possibly residential space, together with a new Kendall Square subway station will limit the Institute's expansion to the northeast. To the northwest, on what is essentially the site of a former junkyard, developers are building two- and three-bedroom townhouses. The Washington Elms and Newtowne Court public housing areas are to be rehabilitated. Property near Cambridgeport has been acquired by American Science and Engineering, Inc., for the company's headquarters.

"The area is acquiring the characteristics of a more stable and more substantial investment area," Mr. Simha said. "Competition for land space around M.I.T. is going to become acute. The message is that we have to be very prudent with respect to the use of our land and the use of our space."—*M.L.*

How Much Science? How Much Writing? The CEP Begins a New Review

The faculty's watchdog Committee on Educational Policy has finished the first stage of a new review of undergraduate curricula and degree requirements by identifying what it believes are the three major issues in the undergraduate programs:

☐ How should M.I.T.'s "special concern with science and technology" be reflected in the requirements for undergraduate degrees?

☐ What is an appropriate educational experience in humanities, art, and social science for M.I.T. science and engineering students?

☐ How shall undergraduate curricula be changed in response to President Paul E. Gray, '54 in his inaugural address last fall: "The pace of M.I.T. contributes, I believe, to those centrifugal forces which weaken our shared central purpose and which impair the coherence of our educational programs"?

After deliberating for more than the first half of the 1980-81 year, three CEP subcommittees reported early this spring on the questions (and some possible answers) which seem to them pertinent to the three major issues. "An unusually strong emphasis on science will properly continue to distinguish the M.I.T.'s undergraduate program," wrote a subcommittee on General Institute Requirements in science. But, it is said, there remain some questions: Can a student be considered literate in modern science without some background in the life sciences and in computation, neither of which are assured in the Institute's present science requirements of chemistry *or* biology, physics, and mathematics? How can the present mathematics requirement (two terms of calculus) be broadened to recognize that many students already have calculus when they enter M.I.T. and to somehow emphasize "qualitative solutions and approximation bounds" instead of methods of obtaining single correct numerical answers, an issue first raised by President Jerome B. Wiesner and Chancellor Gray in their annual report for 1976-77. And how much experience should be expected in laboratory work *per se*?

No one doubts that humanities must be a part of an M.I.T. education, even for the most dedicated engineering student. To assure richness, present humanities requirements include both distribution and concentration, and the subcommittee found the distribution requirement so "lofty" in purpose as to be essentially "unrealistic." Furthermore, they said, competence in writing is not assured by the present humanities requirements, and the subcommittee hints at the need for a writing requirement—a test of the writing ability of every student, with those who need them being required to take Writing Center courses.

Finally, a subcommittee on Pace and Programs had perhaps the toughest assignment of all: How can students be prepared for work without increasing pace and pressure in the traditional disciplines as they become more and more complex? Many students now respond to this dilemma by routinely registering for overloads, creating what the subcommittee calls an "overload problem." Many departments respond by early requirements which subvert students' flexibility to choose and change their majors, or by setting requirements which are in fact "significantly more" than the Institute graduation requirement. Deliberations on these issues are complicated by the finding that the units assigned to a course and the work required to complete it are often inconsistent, said the subcommittee.

Having received and published its subcommittee reports, the CEP said it would welcome student and faculty responses, and that it might be ready with some specific proposals by next fall which would continue "the process of evolutionary change in undergraduate education."

Responses began quickly enough. Stephanie Pollack, '81, editor of *The Tech*, warned that the report hinted at "significant restrictions of student choice."

Mark Sloan, '81

William J. Hecht, '61: On Playing Change-Manager

"I've always felt M.I.T. was an unusual place. So it should do unusual things. And at our best, as an institution, we *do* that."

When this line of thinking is applied to the Alumni Association, says William J. Hecht, '61, it means that "we establish new kinds of relationships." I asked Mr. Hecht about his experience and goals after almost a year as executive vice-president of the Alumni Association. He spoke of many different concerns:

On the job: I like to play change-manager. We have a new administration; it's a time when we can try new things. I've always had ideas about the directions the Alumni Association takes, and the opportunity to explore them came about with this job.

I find that the Institute and the Association are more complicated than I had thought. But I see that as a richness, not a problem. I like complicated things. In a few places, I think things were more complicated than necessary. The solution is to understand where we are complex because we have to be and where our problems were simple but were made complicated.

There is a remarkable similarity between business and volunteer organizations: volunteers are not so different from clients; we serve them. I enjoy working with volunteers—they always bring new perspectives, and it's hard to get ossified when you listen to them.

On the marketplace: The Alumni Association confronts a marketplace that's difficult to understand. There is no such thing as a single prototype alumnus. We will never reach everyone and there is a constant element of change; the graduating group of 10 or 15 years ago has different needs and different problems than older or current classes. What we need is more feedback on our efforts to stay in touch with this varied group, and more sensitivity to the feedback we get.

On students: When a student graduates, he or she suddenly joins the alumni. We want to communicate with them before that point, so we have a relationship to build on.

On contributions: Alumni contribute in many ways that are hard to measure: spending time as part of a visiting committee, serving as solicitor for the Alumni Fund, participating in the Fund, Educational Council, or clubs. The potential for commitment is vast. What role can an alumnus who is involved in a leading edge of technology play? How can we capture his or her expertise for education or research? The Undergraduate Research Opportunities Program (UROP) taps those resources; perhaps there are other ways.

We need to have a large number of people involved. And we have a huge opportunity to do this now, because President Paul Gray is extraordinarily well respected by alumni.

On communication: Alumni are not just in Cambridge. Their perception of M.I.T. is different at a distance—they receive much less information; they have fewer opportunities to be involved. While we use all kinds of activities for this now—the Educational Council, clubs, Fund activities and *Technology Review*—we also have to be ready to make use of developing communications technology. When I look at the year 2,000, I see that we'd better be doing more than writing and talking; we must evolve with new methods of communications.

On the future: I believe M.I.T. has the capacity to effect change in society at large, and I'd like to see us as a community take that opportunity in the best way possible. In a sense alumni are more a part of the larger community than we are, because they're *in* it. As we link the alumni with the Institute, we can help close the gap between the society at large and the Institute. We must learn better how to forge and use that link.—*M.L.*

A New Thrust for Science for New York's Disadvantaged

by Barbara Goldoftas

The closest link between M.I.T. and Harlem right now may be Delois Blakely, community fellow in the Department of Urban Studies and Planning (DUSP). But Ms. Blakely is working hard to change that situation, using M.I.T. resources to plan a community education center—the Harlem Institute for Science, Technology, and Economics—which she hopes will encourage minority youth to pursue careers in science and engineering.

Black students traditionally have not entered scientific professions. Although over 11 percent of the U.S. population, blacks comprised only 0.7 percent of all engineers, 3.8 percent of all mathematicians, and 1.6 percent of physical scientists in 1976—in total 0.9 percent of the 800,000 professionals in these fields (U.S. Bureau of Census). Thinking about this under-representation of minorities in the scientific professions and the valuable viewpoints that minorities could bring to them, Ms. Blakely came upon her vision for the Harlem Center. She believes that a lack of role models and scholastic encouragement and inadequate pre-college educational opportunities, especially in the early years, are the principal problems for blacks, and she wants her Harlem Center to offer both the educational and personal opportunities the black youth need to enter science-oriented high schools and continue to universities such as M.I.T. Her strategy will be to enlist the participation of many scientists and to provide well-equipped laboratories in which disadvantaged students may discover the real fascination of disciplined scientific studies.

The M.I.T. community has provided Ms. Blakely with some essential encouragement and support, and she will return to New York this summer with a framework to be implemented within the next three to five years. Advisors in the DUSP have helped her to design a layout for a converted brownstone, and Sloan School faculty members have suggested management and administrative designs and short-, medium-, and long-term goals for funding. In addition, Ms. Blakely has been able to assemble a strong advisory board from among the academic, corporate, and community resources that will support her project after she leaves M.I.T. Professor Frank Press, president-elect of the National Academy of Sciences, has agreed to join the board and encouraged her to continue "full speed ahead" on the project regardless of current trends in educational and social services.

Delois Blakely

During her year at M.I.T. as a community fellow, Ms. Blakely also has studied the work of other programs for minority students. She especially cites Project SEED (Special Elementary Education for the Disadvantaged) which helps elementary school children prepare for pre-college math courses in high schools. In cooperating schools all over the country, including eight in the Boston area, professional mathematicians and scientists teach abstract mathematics on a daily basis to regular classes of disadvantaged children. The children not only learn the abstract mathematics; they also improve in the basic arithmetic which is part of their regular curriculum.

Ms. Blakely should have no trouble launching an equally successful program in New York City. Her qualifications include familiarity with the Harlem community, experience developing embryonic institutions, and a strong vision—the elimination of racism. Toward this goal she founded the New Future Foundation in 1969—a community organization that sponsors workshops and programs in which children from all ethnic and economic backgrounds work together to understand various cultures and ways of living, including their own. Just as the Foundation gives children a glimpse of a free and equal society, Ms. Blakely believes that the Harlem Center will prepare youth with the vision of an egalitarian future.

Delois Blakely's dedication to social and community services began during her 10 years as a nun in New York, where she worked with prison inmates and city youth before she left the convent to devote herself to civic duties. Since then she served on the U.S. National Commission on the International Year of the Child, designed community youth programs and children's films, and visited China as a member of the U.S. Education Delegation before coming to M.I.T. to study with the community fellows. (Photo: Barbara Goldoftas)

Dorothy W. Weeks, '23 (left), was a protégé of its director, the late Professor George R. Harrison, when M.I.T.'s first spectroscopy laboratory was dedicated in 1932. Forty-eight years later Ms. Weeks, now retired after a distinguished career in physics at Wilson College, was greeted by President and Mrs. Paul E. Gray, '54, as she returned on March 6 for a second dedication—that of the George Russell Harrison Spectroscopy Laboratory—in the same room as the first one. (Photo: Calvin Campbell)

A New Milestone in Spectroscopy at M.I.T.

Every atom and molecule has its own signature—the particular wavelengths of energy it radiates or to which it resonates. Even before George R. Harrison came to M.I.T. from Stanford in 1930, lured by the promise of a new emphasis in science under President Karl T. Compton, spectroscopy—the science of these emanations—was recognized for powerful leverage toward understanding atomic and molecular structure. But Professor Harrison's systematic study utilizing spectroscopic gratings of unprecedented accuracy and size (they could only have been made at M.I.T.) brought spectroscopy to a new level of accomplishment and usefulness. The *M.I.T. Wavelength Tables* which he compiled between 1930 and 1939 are still a standard reference work.

Now Professor Harrison's achievements in spectroscopy—and his later contributions as dean of the School of Science for 22 years—are commemorated in the new name for the spectroscopy laboratory which he founded, and the laboratory itself has been refurbished and given an additional role as the focus for the M.I.T. Regional Laser Center.

At rededicaton ceremonies on March 6, President Paul E. Gray, '54, paid tribute to "the remarkable quality and range" of Dr. Harrison's contributions to M.I.T.; Howard W. Johnson, chairman of the Corporation, cited his "large wisdom and sense of humanity—a remarkable confluence of abilities and traits that endeared him to all of us"; and Dr. Harrison's widow, Betty, added a tribute to the Institute: "When George moved to Cambridge," she said, "he found the love of his life."

The science which Dr. Harrison pioneered has translated itself into "literally billions of dollars of savings to U.S. industry—a monumental role," said Dr. Arthur F. Findeis, director of the National Science Foundation's Regional Instrumentation Facilities Program, through which had come most of the funds for the new laboratory to create the new George Russell Harrison Spectroscopy Laboratory. And, Dr. Findeis said, he and his colleagues are confident that the laboratory will make contributions of equal importance in the future.

The contributions of Dr. Harrison through spectroscopy were in the visible spectrum; his successor, Richard C. Lord, professor of chemistry emeritus, concentrated especially on the spectra of polyatomic molecules in the infrared spectrum; and with the selection of the laboratory's third director, Michael S. Feld, '63, lasers became the central research tool and the interactions of molecules with laser energy the principal subject of inquiry. From this work, speculated Professor Feld during the rededication ceremonies, may well come a new kind of chemistry in which reactions are stimulated by radiant instead of heat or chemical energy and almost surely will come growing medical uses of lasers. Already the Regional Laser Center has one of the most extensive collections of research lasers available anywhere in the U.S.

A morning symposium to mark the dedication brought three distinguished speakers to Kresge Auditorium: Edwin H. Land, chairman of Polaroid Corp., with a brilliant lecture on how we see color in the visible spectrum (we see it not in large areas but at the fringes, where different colors interface); Gerhard Herzberg, of Canada's Herzberg Institute of Astrophysics, on free radicals, elusive molecules such as triatomic hydrogen (H_3)for whose study spectroscopy is the chief tool; and Charles H. Townes of the University of California, Berkeley, who descibed his use of spectroscopy in studies of the nebula in the constellation Orion. (So many of the molecules in the ionized gases associated with this nebula are acting as masers—amplifying the radio energy they receive from the nebula—that they represent the most powerful radio source in the universe; and the dust clouds surrounding the nebula contain enough material to form perhaps 1 million stars, Professor Townes thinks.)

English Spoken Here?

by Steven Solnick, '81

I was having dinner last week in a tiny North End restaurant with three friends, all M.I.T. people. The alumnus on my left asked for linguini in garlic and oil.

"Certainly," the waitress replied, "but that will be fifty cents extra."

"I don't mind," my alum friend shrugged. "Just out of curiosity, though," he asked, "what's the default case for the sauce?"

The waitress gave a puzzled stare, and I almost gagged on my chianti. It took a hearty order of garlic bread to restore my appetite.

Only an M.I.T. person, as best as I could tell, would ask about the "default case" for sauce, instead of just asking what the sauce "normally is."

Many M.I.T. students and alumni have the most annoying habit. They often forget that the whole world doesn't understand what they are saying, or doesn't care. What may not raise an eyebrow among four Engineers may often pass as Paraguayan to the "average" human being.

A freshman friend (freshfriend?) of mine was once discussing her difficulties with dating four or five guys at the same time (as M.I.T. coeds may be wont to do). She did not refer to juggling her dates, however. She discussed, instead, her "multiplexing."

On another occasion I was discussing the Undergraduate Association elections with someone familiar with the candidates. Rather than saying, "Candidate A has more potential to do great things, but Candidate B is more certain to do at least some good," he pulled out a piece of paper. And drew a pair of axes. And graphed the candidates.

One friend of mine complained that he wanted to avoid strenuous activities because he "just ate 50 percent too much." What precision.

A fairly large group of M.I.T. students seem to have forgotten that "mumble" and "sigh" and "groan" are sounds to be made. They are not, in *normal* verbal intercourse, generally interchangeable with the words which describe these sounds. That doesn't seem to stop our etymological pioneers, though. Oh, grumble.

Often M.I.T. students seem totally oblivious to the fact that they are marching to the sound of a different drum—or at least, reading from a different dictionary. There's nothing wrong with individuality, mind you, only insensitivity to differences.

For instance, I saw a commercial the other day for smoke detector alarms. Captioned in sign language for the deaf. An interpreter inset into the bottom right corner of the screen signing "When you hear the smoke alarm, move to the. . . ."

It's times like that I am inclined to favor a mandatory foreign language requirement for college students. It might never matter whether you know Nepalese or not in this or any other succeeding life. But it may do you an awful lot of good to realize that not everyone speaks the same language. That may give you a hint that not everybody thinks the way you do. If you're lucky, that, in turn, may suggest that not everyone shares the same set of values.

Sometimes a dinner party can feel like a night in Nepal.

I was at one with my living group a few weeks back, and after the meal was concluded we were amusing ourselves with the variety of puzzles which decorate our housemasters' apartment. I was pleasantly surprised to come across a puzzle that had once gripped me in many hours of frustrated devotion in grammar school.

The puzzle involves arranging four cubes so that different colors are displayed on all sides. In my entire life I have solved this puzzle but three times and they were glorious moments.

As I sat toying with these cubes, reliving my tortuous but precious triumphs, a math major sat down next to me and examined the cubes one at a time. He picked up a napkin and began drawing graphs with a green magic marker. He was solving the puzzle, my old nemesis, by graph theory.

Once I realized this, I attacked the problem by brute force of reason. The race was on. I could not let the obsession of my childhood go so easily.

But graph theory had it solved in 35 minutes, after some consultation with a computer scientist. I felt vanguished, and very empty.

There was certainly a different drummer tapping in that room. What did the graph theorist feel, I wondered, after taming "Instant Insanity?" Was there a rush of sheer elation? Was there that wave of exultant triumph that can only come after hours of frustrating and dedication? Was there any sense of a flashback to childish glee?

I think not. Only a smug satisfacation in the superiority of mathematics over frenetic human—very human—pluck. What else could I expect from a cult that races to solve the demonic Rubik's cube in under two *minutes*.

I toyed with the cubes a bit longer after the mathematician discarded them. But there was no longer any challenge, any excitement, any energetic optimism, any *fun*. I'd just seen the damn thing solved with a magic marker and a napkin. There wasn't even a need to touch the cubes. It wasn't a game any more; just an exercise I could no longer muster the will to do.

The lip-biting, hair-pulling, tongue-between-the-teeth episode of the old days was not to be relived—not that night anyway.

Yesterday I was sitting in Lobby 7. Behind me sat a woman holding some papers and a pink, twisted balloon form.

Thinking the worst, I asked her, "Is that a molecule?"

"No," she replied, in puzzled tones, "It's a poodle."

"Thank God," I blurted, blushing, and took off down the corridor.

There may be hope yet.

Letters

Science Without Problem Sets?

Could it be true, as Steven Solnick (*"Would You Send Your Kid To M.I.T.?"*, January, p. A9) asserts, that M.I.T. students don't have enough time to explore and grow?

Our credit unit system, which never ceases to perplex outsiders, has the purposes of constraining faculty to keep demands within bounds and of guiding students to reasonable course loads. It is a fairly reliable guide, and using it a student need take only 45 units per semester to graduate in four years—which certainly doesn't use up all the available time. To those who would complain that 45 hours of course work each week doesn't leave one with enough energy for intense alternative activities, I would point out that the two semesters occupy only about 60 percent of the year. There are two big breaks each year, and M.I.T. explicitly encourages undergraduates to use one of them (Independent Activities Period) to engage in exploration and growth. The Undergraduate Research Opportunities Program (UROP) provides yet another way of pursuing individual interests; UROP students are encouraged—and often paid—to engage in activities where they can bring their own initiative and creativity into play. There are also a number of regulations, some of which may not be well known, to ease the way for students who want temporary relief from the regular academic program—registration for a reduced load (with reduced tuition), leaves of absence (with the assurance of readmission), and "junior year abroad" or "domestic year away" programs.

Mr. Solnick complains that problem sets lock students into such structured, overwhelming activity that they have no time left for anything else. But problem sets are supposed to make life easier for students, not harder. Nothing can match the well-organized course as a means of bringing the learner up-to-date and ready to be independent, and problem sets are often an essential element of that organization. When faculty colleagues of mine have tried to teach science courses without problem sets, they've discovered that the students want problem sets and find them useful.

I do not say that we don't have a problem. An M.I.T. education is certainly a challenging one; perhaps it doesn't leave enough unstructured time. But if there is a problem, it will take a deeper analysis than we have seen to pinpoint the cause.

Charles E. Holt,
Professor of Biology, M.I.T.

The Ivory Tower Going Silicon?

Steve Solnick is right about problem sets: after becoming used to measuring progress by success with problem sets, students lose a good bit of their initiative and interest in attaining long-range goals; problem sets do make life easier, as Professor Holt (*see above*) suggests, by providing a weekly crutch which supports the failing personal initiative.

By its nature, engineering as practiced in industry requires systematic, if often uninspired, effort. Current products make money, not brilliant ideas for the future. As much as we would like to think of M.I.T. as what Walter Rosenblith once called "a liberal technical school" concerned with basic research, we must recognize that M.I.T. exists largely to serve American industry. *Electronics* magazine paraphrases Professor James D. Bruce, Sc.D. in saying that M.I.T.'s "new administration is looking now for more input—and assistance—from industry in drafting its academic course." Maybe this highly organized marriage of convenience helps to put some of Steve Solnick's remarks into persective. I venture to guess that if M.I.T. trained only social scientists and men of letters we wouldn't have problem sets. To paraphrase Professor David Noble, it seems that the ivory tower has gone silicon.

Harry Atwater, '81

Maturity and Self-Confidence

Many editors would have suppressed statements of self-examination such as Mr. Solnick's if they were even remotely critical of their institutions. The inclusion of the essay in the *Review* demonstrates an admirably high degree of maturity and self-confidence of both the magazine and its institutional sponsor.

Bruce Herrick, Ph.D.'64
Professor of Economics
Washington and Lee University

For Me, but Not for All

It's true, as Steven Solnick implies, that M.I.T. is not geared for a typical undergraduate education or a normal social life (whaever that is). As with everything else at M.I.T., if a student wants a broader educational base, a more "normal" social life, or a closer connection with current events, that student is going to have to work for it, often quite hard.

There is no way to force people to broaden their horizons if they don't want their horizons broadened. Required classes won't necessarily get people to like literature, history, or politics. However, the Institute must be careful to provide *and encourage* means for students to voluntarily become more well rounded. I assume from his Inaugural address that this is one of the more important topics of discussion in President Gray's office currently.

M.I.T. is not a college well suited for everyone, nor is everyone well suited for M.I.T. It would be a tremendous shame if M.I.T. as a college should try to generalize its base too much to accommodate the desires of all. The Institute's position among science and engineering schools would be seriously threatened if resources were spread too thinly. Already laboratories are overcrowded, professors are overworked, classes are understaffed, and facilities are overloaded.

I have enjoyed and benefitted from M.I.T.; there is no reason to suspect that my children could not in the future.

Gordon B. Hunter

Courses

A big year for Course VI-A, as one of its alumni becomes president of M.I.T. and the course itself claims a record number of applications from electrical engineering sophomores. The picture shows John A. Tucker (center), director of the VI-A Program, with President Gray (right) and Doran L. Morrison, who represents General Electric Co.'s Ordnance Systems Section, Pittsfield, Mass., in the VI-A Program. GE was the first company to associate with the VI-A Program, and Mr. Morrison is one of the longest-tenured representatives. (Photo: Calvin Campbell)

I
Civil Engineering

Alan Katz, S.M.'75, has recently finished a judicial clerkship with a member of the Louisiana Supreme Court and has entered into private law practice with the firm of Gordon, Arata and McCollam, New Orleans, La., specializing in oil and gas law. . . . **Roger Arndt**, S.M.'62, is a professor and director of the Saint Anthony Falls Hydraulics Laboratory at the University of Minnesota. He spent three weeks last year lecturing in China on hydraulic engineering and is active in aeroacoustic and cavitation research. . . . **Edward R. Holley**, Sc.D.65, a professor at the University of Texas, Austin, won the 1980 Karl Emil Hilgard Hydraulic Prize of the American Society of Civil Engineers as co-author of a research paper, "Temporal Moments for Longitudinal Dispersion."

Albert G.H. Dietz, Sc.D.'32, a member of the faculty, has been made an honorary member of the American Society of Civil Engineers. All of his professional life has been spent as a faculty member at the Institute and for the past ten years he has been professor of building engineering in the Department of Architecture, where is now professor emeritus. . . . **Francis S. Lynch**, Sc.D.'68, has joined the General Electric Research and Development Center, Schenectady, N.Y., as manager of Industrial Information Systems.

IV
Architecture

Anthony Tappe, M.Arch.'58, has been elected to fellowship in the American Institute of Architects. . . . Caudill Rowlett Scott, Architects, Engineers and Energy Planners, Houston, Tex., of which **William W. Caudill**, M.Arch.'47, is a founding partner, won two citations in the Owens-Corning Fiberglas Corp.'s 1980 Energy Conservation Awards Program. The firm was cited in the commercial-design category for substantially reducing the need for artificial lighting in its design of Shell Oil Co.'s Exploration and Production Office in Woodcreek Park, Houston, Tex., and in the governmental-built category for integrating energy-conserving elements into the design of a federal correction facility in Bastrop, Tex. . . . **Bernard P. Spring**, M.Arch.'51, since September 1, 1980, has been president of the Boston Architectural Center.

VI
Electrical Engineering and Computer Science

A $500,000 gift from ITT will support the ITT Career Development Professorship in Computer Technology, providing support for promising young faculty members in the fast-growing field. **Paul E. Gray**,'54, President, no doubt thinking of the extreme pressures on the department's present faculty because of high student enrollment, calls the gift "an outstanding example of corporate support for private higher education."

James R. Melcher, Ph.D.'62, recently named director of the High Voltage Laboratory, is now Julius A. Stratton Professor of Electrical Engineering and Physics; the appointment honors the work that has made him the acknowledged "father of continuum electromechanics," says Professor Gerald Wilson, '61, head of the department. The Stratton chair was established last year under a gift from William R. Hewlett, S.M.'36, chairman of the Executive Committee of Hewlett-Packard Co.

Raymond A. Bruce, S.M.'61, has been named director of the Transmission Technology Laboratory, Bell Laboratories, Holmdel, N.J. . . . **Rudolph Dreschler**, S.M.'65, has been named head of the Hybrid Circuit Department, Bell Laboratories, Allentown, Penn. . . . **Carla Marceau**, S.M.'70, writes, "My husband and I have adopted an Indian baby, Reena Vogt and I am continuing to work as a manager of software development at NCR." . . . **Mark A. Orenstein**, S.M.'68, has been named director in the Data Processing Department at The Travelers Insurance Co.

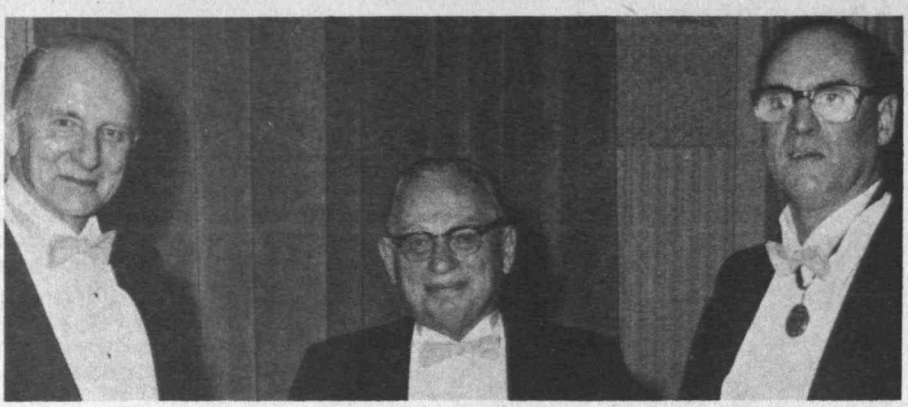
Frederick H. Merrill, S.M.'37, a former employee of Imperial Chemical Industries Ltd., England, passed away on November 24, 1980. . . . **M. Alten Gilleo**, Ph.D.'48, formerly manager of the Optical Processes Department of Allied Chemical Corp., Morristown, N.J., died on November 14, 1980.

VI-A Program

Applications for the VI-A Program hit an all time high of 195 this spring. This is a 15.4 percent increase over last year's peak and represents 55.9 percent of the sophomores enrolled in Course VI. From this group about 85 will be selected for the new VI-A class to start in June. During two days on campus in March the 23 cooperating companies conducted 1,030 student interviews—a record from VI-A and 12 percent of the total conducted of at the M.I.T. Placement Office in a year.

Joining VI-A this spring is Tektronix, Inc. Two alumni, Dr. **Delmer L. Fehrs**, '63 and **Robert G. Rullman**, '51, represented Tektronix at the annual VI-A business meeeting and open house. Assisted by **Steve Swerling**, '63, they covered the interviews for those applicants interested in Tektronix.

VI-A alumni were well represented amongst those representing their companies. They were: AVCO—**Donna B. Northam**, '70; Bell–**Victor L. Ransom**, '48; Codex—**David M. Ryter**, '80; Draper Labs—**W. Sumner Brown**, '66, **Jonathan R. Leehey**, '78 and, **Alan E. Schutz**, '65; Hewlett-Packard—**Lawrence W. Banks**, '67, **William R. Bidermann**, '76, **William A. Rytand**, '65, and **Kenneth A. Van Bree**, '71; Honeywell—**Jeffrey C. Gelpey**, '75; Lincoln Labs—**Joel A. Feldman**, '79, **Jeffrey T. Millman**, '71 and, **Scott C. Munroe**, '75; NSWC—Dr. **Wallace K.L. Ching**, '65 and, **William G. Scott**,



Ralph Landau, ScD.'41, president of Halcon International, Inc., receives the 1981 Perkin Medal of the American Section of the Society of Chemical Industry. The presentation is by Edward Jefferson (left), chairman of the American Section; Sir Maurice Hodgson (right), chairman of ICI, introduced Dr. Landau for the award, one of the most prestigious in American industrial chemistry.

'78; Raytheon—**Troy E. Plunk**, '61; RCA—**Daniel M. Sable**, '80; TI—Dr. **Dean R. Collins**, '58; and Xerox—Drs. **Russell R. Atkinson**, '80, and **D. Austin Henderson**, '75.

This year the annual business meeting was opened with remarks by President **Paul E. Gray** '54. Earlier in his career Dr. Gray served as a VI-A faculty advisor to the Boston Edison Co., American Electric Power Corp., and the former Naval Ordnance Laboratory. The balance of the business meeting was conducted by John A. Tucker, who is serving his 12th year as director of the VI-A Program.

Returning to a VI-A faculty advisorship position is Professor Emeritus **Truman S. Gray**, '29. He'll act as a liaison to the Houston facilities of Texas Instruments, Inc. Replacing Professor **Joel Moses**, '67, as VI-A faculty advisor to Draper Labs will be Professor **Jeffrey H. Lang**, '75. Professor **David H. Staelin**, '60, who has been VI-A faculty advisor to General Electric/Pittsfield, has become advisor to COMSAT. His GE position is beng filled by **Bruce D. Wedlock**, '56, Director of M.I.T.'s Lowell Institute School and director of patent marketing.

Taking over from Director Tucker a VI-A faculty advisor to Hewlett-Packard Laboratories in Palo Alto, Calif., is Professor **Jonathan Allen**, '68. Coordinating VI-A for Hewlett-Packard Co. now, is **William A. Rytand**, '65 of Sunnyvale, Calif. Since Dr. Walter H. Olson has left M.I.T. to join the staff of Medtronic, Inc., his advisorship position at Medtronic has been filled by Professor **G. Mark**, '60.

It is interesting to note that seven of the 24 members of this year's Course VI Visiting Committee are VI-A graduates: **C. Gordon Bell**, '56 (vice-president—engineering, Digital Equipment Corp.); **Paul Hotte**, '42 (Corporation member);**Joseph F. Keithley**, '37 (chairman, Keithly Instruments, Inc.); **Howard L. Richardson**, '31 (Corporation member); **Lawrence G. Roberts**, '59 (chairman, Telenet Communications Corp.); **Raymond S. Stata**, '57 (president, Analog Devices, Inc.; and **William R. Thurston**, '43 (president, GenRad, Inc.). Congratulations on their achievements.

Professor Emeritus **Karl L. Wildes**, '22 tells of a pleasant visit he had from VI-A graduate **Donald R. Erb**, '40. Don serves as Secretary of the Class of 1940 and gave Karl a nice write-up in the Class Notes section of the January, 1981 issue. He tells of the work Karl is doing preparing a history of the department to celebrate its 100th anniversary next year. Co-author with Karl in this undertaking is another VI-A graduate, **Nilo A. Lindgren**, '48.

Visiting M.I.T. as team leader for Hewlett-Packard recruiting was **S. Dana Seccombe**, '70, from Loveland, Col. Dana is also instrumental in the coordination of VI-A with Hewlett-Packard. **David E. Meharry**, '71, tells us that starting in March he will be with Sanders Associates, Nashua, N.H.

Recent alumni visitors to the VI-A Office have included: **David M. Bernstein**, '74, interviewing for TRW, Inc.; **John W. Jarve, Jr.**, '78, who is working at Harvard Medical School and plans to attend business school next fall; **Mark S. Linsky**, '72, from Hewlett-Packard, Cupertino, Calif.; **Steven E. Richardson**, '73, from Hewlett-Packard, Boise, Idaho, and **Robert C. Sherrick**, '75, who expects to attend medical school in the fall.—John A. Tucker, director, VI-A Program, Room 38-479, M.I.T., Cambridge, MA 02139

X
Chemical Engineering

The 75th award of the Perkin Medal by the American Section of the Society of Chemical Industry (London) was made to **Ralph Landau**, Sc.D.'41, chairman and chief executive officer of Halcon International, in New York on February 13. Dr. Landau already holds the SCI's Chemical Industry Medal—the first person since World War II to receive both honors and only the fifth ever. Nine major chemical process developments during the last 35 years are credited to Halcon International and its predecessor company, Scientific Design—"more than the total from any other single source and a substantial fraction of the total from all sources," writes William Fallwell in *Chemical and Engineering News.*

Ralph R. Paxton, Sc.D.'49, wrote *Manufactured Carbon: A Self-Lubricating Material for Mechanical Devices*, published by CRC Press, late in 1979. . . . **Joseph J. Paterno**, S.M.'65, is currently divisional vice-president and general manager of the Organic Grinding and Wheel Division at the Norton Co., Worcester, Mass. . . . **Irwin J. Gruverman**, '55, has been named executive vice-president—operations at the New England Nuclear Corp., Boston, Mass. . . . **A. David Rossin**, S.M.'55, of the Commonwealth Edison Co., was a speaker on "Nuclear Reactors: Risk and Reason" at a New York press briefing of the American Nuclear Society early this year.

A Message to Reagan on What to Do for Cities

What should President Ronald Reagan do to help American cities?

He should pick programs that go to the heart of problems and troubles, and he should insist that everyone work together to implement them, says Professor Lawrence E. Susskind, Ph.D.'73, head of the Department of Urban Studies and Planning. Professor Susskind thinks these six programs could be financed without new resources by reprogramming general revenue-sharing funds, community development block grants, and some other existing programs:

☐ Guarantees of low-interest money for improving streets, water supplies, harbors, airports, urban parks, pollution control, water and energy conservation, noise abatement, traffic safety, and the like. ("It is perfectly legitimate," writes Professor Susskind in the department's newsletter, "for the federal government to help protect the basic infrastructure of cities just as it preserves large spaces elsewhere," and it is unrealistic to expect cities which are in competition with each other to spend their own money to increase environmental controls.)

☐ Housing programs to combat price inflation and subsidize people who are unable to buy. The key to stabilizing housing prices, says Professor Susskind, is increasng housing supply; he urges that federal production subsidies and home-buyers' supports be retained, and he wants stiffer taxes to reduce speculation in real estate.

☐ Encourage economic development by using federal money like venture capital to start promising projects, and by requiring companies that do more than $1 million of business with the federal government to allocate at least 5 percent of their business in targeted urban areas.

☐ Give tax incentives to employers and financial incentives to local governments to hire people receiving unemployment benefits.

☐ Help public schools run courses targetted to local employment opportunities, and help students to attend them.

☐ Require every city to prepare an overall strategy for improving targetted urban areas. ("We must find ways of bringing together federal, state, area, local, and neighborhood representatives to set investment priorities," writes Professor Susskind.)

XI
Urban Studies and Planning

Robin Moore, M.C.P.'67, writes, "I am involved in a variety of projects related to community participation in planning, design and management of environments, especially regarding participation by children and youth and people with disabilities. I have also been co-directing an international case study documentation project." . . . **Dean R. Johnson**, M.C.P.'78, has recently assumed the position of executive director of the Boston Harbor Associates, a nonprofit group dedicated to the rational use/reuse of the Boston Harbor. . . . **Alan Rabinowitz**, Ph.D.'69, reports that the American Management Association has just published his book, *The Real Estate Gamble: Lessons From Fifty Years of Boom and Bust*, based on a Ford Foundation-sponsored research project on the history of the real estate investment industry.

XII
Earth and Planetary Sciences

Victor Dolmage, Ph.D.'17, one of Canada's most distinguished engineering gelogists, died recently in Vancouver, British Colombia. . . . **Douglas G. Brookins**, Ph.D.'63, recently published a paperback treatment of *Earth Resources, Energy, and the Environment*. . . . **Robert W. Decker**, S.M.'51, and his wife Barbara, recently published two timely paperbacks on volcanoes: *Volcano Watching* (1980) and *Volcanoes* (1981). In 1979 he left Dartmouth College as professor of geology to become scientist-in-charge at the United States Geological Survey's Hawaiian Volcano Observatory.

Robert J. Foster, '51, brought out a fourth edition of his popular *Geology* in 1980. . . . **M.L. Jensen**, Ph.D.'51, recently produced a revised printing of the third edition of *Economic Mineral Deposits* (1979), with Alan Bateman. . . . **Robert C. Clark**, Jr., '66, is currently a research oceanographer with NOAA's Environmental Conservation Division, Northwest and Alaska Fisheries Center, Seattle, Wash. Tanya Atwater, a student from 1960-63 and more recently a faculty member, is now professor of marine geophyiscs in the Department of Geological Science at the University of California, Santa Barbara. . . . **Robert D. Butler**, Ph.D.'37, reports that he continues to enjoy retirement at his home in Sarasota, Fla.—Robert R. Shrock, Professor Emeritus, M.I.T., 54-1026, Cambridge, Mass. 02139

XIII
Ocean Engineering

Robert I. Price, '53, commander Atlantic Area, United States Coast Guard, has been elected a Fellow of the Society of Naval Architects and Marine Engineers. . . . **Claude R. Thompson**, '56, a retired U.S. Coast Guard captain, recently joined Parsons Brinckerhoff, McLean, Va., an engineering, architectural, and planning firm. He will be involved in expanding the firm's role in the design of coal transshipment facilities along the Gulf Coast and Atlantic seaboard. . . . **Joseph W. Naab, Jr.**, S.M.'44, a retired Coast Guard Captain of 27 years' service, passed away on December 12, 1980. Captain Naab retired in 1964 after serving on convoy duty during World War II and as commanding officer of the cutter Yakutat and later the icebreaker Eastwind. Following retirement he had taught at Mitchell College, New London, and the University of Connecticut.

John J. Macan, S.M.'62, resigned as Acting Chairman and Chief Executive Officer of Atwood Oceanics, Inc., Houston, Tex., to pursue other activities. . . . **Alexander J. Tachmindji**, S.M.'51, vice-president and general manager of Washington operations in command, control, and communications for the MITRE Corp., McLean, Va., has been elected a Fellow of the American Association for the Advancment of Science.

Sloan Fellows

Stephen H. Howell, S.M.'66, was recently named executive vice-resident, energy distribution and general service, for Consumers Power Co., Jackson, Mich. . . . **Aurelio Madrazo**, S.M.'74, was named President and Director of MCO Resources Inc., Los Angeles, Calif., a gas and geothermal exploration concern. . . . **Herbert L. Shuttleworth, II**, S.M.'37, has announced his retirement from Monhasco Corp., Amsterdam, N.Y., after 43 years of service with the company. . . . **William H. Springer**, S.M.'68, has been elected executive vice-president—finance of Illinois Bell, Chicago; he is the chief financial officer of the company and continues to serve as well as comptroller and secretary.

Robert M. McGeorge, '60, of Tucson, Az., passed away on May 17, 1980. . . . **Walker M. Benning**, '63, president of Twin City Realty, Benton Harbor, Mi., died on October 19, 1980.

Senior Executives

Paul V. Garvin, '65, of San Francisco, Calif., passed away on November 19, 1978. . . . **Billy J. Lancaster**, '61, of Dallas, Tex., died on August 12, 1980. . . . **Joseph A. Baute**, '64, chairman and chief executive officer of the Markem Corp., Keene, N.H., has been named Class B director of the Federal Reserve Bank of Boston. . . . **Harold A. Shaub**, '57, is retiring as president and chief executive officer of Campbell Soup Co., Camden, N.J., but will remain a director, and **Alexander M. Williams**, '63, corporate senior vice-president and president of the canned foods division, was elected one of two executive vice-presidents. . . . **Richard L. Terrell**, '58, formerly Vice Chairman of General Motors Corp., was elected a director of Ashland Oil Inc., Ashland, Ky.

O.M. Sievert, '69, is presently chairman of Solar Turbines International. . . . **James L. Oberg**, '58, former president and chief executive officer of Smith and Wesson, has been promoted to a corporate senior vice-president of Bangor Punta Corp., Greenwich, Conn.

XIX
Meteorology

David L. Tweedy, S.M.'65, a consultant with Management Systems, Inc., Waltham, Mass., presented a paper, "A Decision-Rule Model for Bulk Terminal Management" at the 1980 Winter Simulation Conference, Orlando, Fla.; the work concerns the use of computer models to manage the distribution of petroleum products for 50 terminals of Sun Oil Co. . . . **Andrew Wagner**, S.M.'58, reports that he is working in the Climate Analysis Center at the National Weather Service/NOAA, on forecasting and research related to monthly and seasonal weather outlooks. He is also conducting various climatological studies evaluating long-range effects.

XXII
Nuclear Engineering

John M. Neill, Sc.D.'61, has established his own consulting business, Advanced Energy Concepts, San Diego Calif., specializing in energy systems, analysis and management. . . . **Charles L. Larson**, Sc.D.'59, is presently on a two-year assignment at the Oarai Engineering Center, 120 kilometers northeast of Tokyo, as Department of Energy technical representative to PNC, the company responsible for breeder reactor development in Japan. Oarai is the site of the JOYO experimental breeder and other reactor development activities. Prior to this assignment, Dr. Larson worked in the Advanced Reactor Systems Department of the General Electric Co., Sunnyvale, Calif.

Daniel J. Kennedy, Sc.D.'69, has recently joined Fichtner Consulting Engineers, Germany, on a full-time basis after completing the M.B.A. program at INSEAD (the European Institute for Business Administration) in Fontainebleau, France.

Classes

John J. A. Nolan, '03 (foreground) with his son, John E. Nolan, at the Technology Day luncheon, June 1980. (Photo: Gordon Haff)

03

John J. A. Nolan, secretary of the Class of 1903, died on January 19, 1981, at home in Louisville, Ky. He was 99 years old, less than three months short of the century mark. He was the last of a large family of five brothers and one sister, with three other siblings not surviving childhood. He enjoyed good health and a keen mind to the end.

To the best of my knowledge, he had attended all M.I.T. reunions since 1903, including 1979 and 1980, which I attended with him. He also was an alumnus of Harvard, Class of 1905, and we were able to attend both college graduation activities on the same trip.

John J. Nolan spent his entire life in the Cambridge/Somerville area until moving to Lousville to be with me and my family in October 1979. During and after college he worked in a family business driving a horse and wagon selling lamp chimneys, wicks, gas mantles, and other supplies to small corner groceries in Charlestown, Chelsea, and "Southie." His father and brothers drove other routes. The advent of large chain stores and the development of electric lighting eventually ended this business.

For a number of years he sold auto insurance and children's shoes, but perhaps the time he enjoyed recalling most was when he worked as a geodesic draftsman detailing all the islands in the Boston Harbor, and then his years in the Boston Naval Shipyard during World War II detailing and revising blueprints for ship construction and war repairs.

For a number of years he gained local prominence for writing and lecturing on historical subjects. Many of his articles were published in the Somerville and Cambridge papers. The Somerville Historical Society labeled him "Somerville's Grand Old Man" in an article written about one of his numerous lectures.

He married Rose LeBlanc and they had two sons, John Edward Nolan of Louisville, Ky., and Paul A. Nolan of Hayward, Calif. His wife died in 1962, and son Paul died in 1979.

After retiring from full-time employment in 1946, John J. Nolan kept busy maintaining and managing family rental property in Somerville and Cambridge. I'm not sure when he assumed the position of class secretary for '03, but he very much enjoyed this post.

In 1979, his last brother died at the age of 96, so the family property was sold and John joined my family and me at our home in Louisville, Ky. The last two years with us in Louisville were some of the happiest of dad's life. He was loved and enjoyed by his family and he made many new friends. He would often accompany me in the car or truck and thought nothing of taking off for a 250-mile trip at a moment's notice. He spent many an afternoon in our shop with the workers and would eat with us at local retaurants every day at noon. He impressed everyone he met with his keen memory, alertness, agility, and a generally cheerful attitude. He started every day with the familiar line, "Not an ache, nor a pain, and almost a hundred years old." But finally, his internal system just wore out and he died peacefully at home in his own bed with his family beside him.

Burial was at St. Paul's Cemetery, Arlington, Mass., on January 23, 1981, in the family plot with his father, mother, and all his brothers and sisters.

Please accept this obituary as a final class report from John J. A. Nolan, Secretary, Class of 1903.–John E. Nolan, 417 Dorsey Way, Louisville, Ky 40223 (502) 425-0883

05

Our Class of 1905 now has eight survivors, according to a computer rundown February 20, 1981. The names are: Colonel **Robert S. Beard**, P.O. Box W, Trinidad, CA 95570; **Silas P. Cumming**; **Roger P. Ingalls**, 724 Brookside Dr., Birmingham, MI 48009; **George W. Prentiss**, 153 Madison Ave., Holyoke, MA 01040; **Hallet R. Robbins**, Orangewood Apt. 2028, 7550 N. 16th St., Phoenix, AZ 85020; **William L. Spalding**, 520 Kenosha Ave., Norfolk, VA 23509; **Gilbert S. Tower** 35 N. Main St., Cohasset, MA 02025; and **Ralph N. Whitcomb** It is wished that some news could be added but none is received, except for one letter from **Bill Spalding** saying, "I am still in good shape, allowing for my 96 years, though the old eyes now require a strong light to read newsprint. My annual physical checkup is slated for Friday the 13th of March, and if the Doc finds nothing serious the matter on that unfortunate date, I probably can last another year. I am being forcibly removed to my daughter's home three miles away. My home for the past 23 years is up for sale." . . . At age 96 the writer is in good health except for blindness and my ankles and feet are weak. . . . I wish **Beard** would write and say what he is doing in Trinidad.—**Gilbert S. Tower**, Secretary, 35 North Main St., Cohasset, MA 02025

08

Mrs. Alexander Emerson writes, "Alex has been in a nearby nursing home for the past year and doing quite well physically, considering his 96 years. He retired 30 years ago from his architectural career which included country houses, some apartments, and commercial enterprises."

Franklin Towle writes, "After Tech I spent three years with a consulting engineering firm (D.C Jackson) and then went into fire protection with a group from Hartford Insurance Co. This led to a Boston insurance agency where I spent nearly 50 years, mostly as a partner; it was not glamorous but interesting and rewarding. . . . I am well but Mrs. Towle is far from it. With one son in the hospital and my housekeeper with a broken leg, I have to stick pretty close to home."

We have sad news to report concerning two of our classmates. Marion (Mrs. **Frederick**) **Peirce** writes, "Frederick received your class letter and would have responded but had a heart block shortly afterwards and died on February 9, 1981. He was active up to this attack and enjoyed his summers at his house in Wellesley Hills and his winters in Boynton Beach, Fla." He leaves his wife, Marion, two children, and five grandchildren.

Richard W. Rawlinson, son of **William W. Rawlinson**, writes of his father's death on November 14, 1979, at the Kennebunk Nursing Home in Kennebunk, Maine, at the age of 94. "My father's business career was in textile manufacturing and he held executive positions with a number of companies in the New England states. At the time of his retirement, he was manager of the blanket division of Pepperell Manufacturing Co. in Biddeford, Maine. After his retirement he continued to enjoy good health, and he and my mother spent the winter months in Florida and the balance of the year at their home in Saco, Maine. Until he suffered a stroke in September 1977, he was active in the community and church affairs and had his driver's license renewed at the age of 92." The class extends sympathy to both families.—**Harold S. Osborne**, Secretary, 375 Highland Ave., Upper Montclair, NJ 07043

13

We regret to report that **Emerson L. Bray** died on September 13,1980, at age 90. Mrs. Bray wrote that he had a beautiful life.

Mrs. **Kenneth Blake** wrote for Ken: "At 88, Ken has lost most of his sight and can no longer do the crossword puzzles and other games in which he delighted. T.V. is pretty much a blur. But his hearing is keen and he greatly enjoys music. We continue to live here on the east side of Lake Washington, with Seattle just across the water. It has been an exciting place to live, having a great variety of leisure time activities. Unfortunately, Ken can now enjoy these only vicariously. Our son, also an M.I.T. graduate, lives near. His work at Boeing as an operations engineer involves much traveling to the Orient and Mideast. This travel, combined with teaching foreign students, affords him a stimulating and satisfying career.

"As a child, I spent many summers in Maine, way down East with my father's family in Columbia—blueberry country. Ken and I have camped all over the state, which we both love." They also sent us a lovely card with a photo of Mt. St. Helens (before eruptions) from across Spirit Lake.

We hear from **Fred Lane** at least once a year, and this year he writes: "Out of Tech for 67 years and retired for 23 years, I'm still enjoying life. Up and around most every day. I still enjoy reading—newspapers and magazines. Out-of-doors when weather permits. Visit my barber when necessary. Do not use a cane. Conduct necessary business in office in my home."

Merrill J. Smith thinks there hasn't been enough news so he writes: "Our daughter and family now live in Maui, Hawaii. My wife and I flew over to visit them in June 1980. We both had been there before but this time we were shown Hawaii in detail. It was a great trip for us. We wanted to see their new home and how they were liking Maui. We were well pleased with all we saw. My wife and I both lawn bowl three or four times a week. We had a big club. Our greens can accommodate 144 bowlers at one time. This evening I was reading about the Maclaurin Pooled Income Fund when it occurred to me that

I have Dr. Maclaurin's signature in the number one 1913 *Technique*. I wish to thank you for your splendid work in keeping the '13 section going." He also sent a copy of the *Rush* showing his name as the first on a list of those who received copies of the 1912 edition of *Technique* with Dr. Maclaurin's personal signature.

Hope you are having a happy springtime.—**Rosalind Capen**, Assistant Secretary and Treasurer, Granite Point Rd., Biddeford, ME 04005

14

Alden H. Waitt, our class president since 1974, died on February 11, 1981, at the age of 88, in San Antonio, Tex. He grew up in Medford, entered the Institute with us and received his bachelor's degree in Course IX-A, with emphasis on chemistry. After two years of teaching at the University of Kentucky, he was commissioned an army first lieutenant in gas-defense service and in 1918 was overseas in the 29th Division as its gas officer. Alden was discharged at the end of the war but accepted the offer of an army commission in 1919. In the mid-twenties he was stationed in the Boston area, attended the Institute, and received his master's degree in 1926. His next duty was with the Chemical Warfare Service in Washington, and after that at Schofield Barracks, Hawaii; the Edgewood Arsenal in Maryland; the Command and General Staff School at Ft. Leavenworth, Kans.; the Air Corps Tactical School in Alabama; and the First Armored Corps at Ft. Knox, Ky.

In 1941 he was again in Washington, attached to the General Staff of the War Department. He became a brigadier general in 1942 and was promoted to major general two years later. He was acting chief of the Chemical Warfare Service at the end of World War II, and chief of the Chemical Corps in 1945. For his military services he received the Distinguished Service Medal, Legion of Merit, Army Commendation Medal with three oak-leaf clusters, and the General Staff Badge; and was made a commander of the Order of the British Empire. Alden continued to live in Washington for a few years after his retirement. In 1952 he moved to San Antonio and began a new career as a successful painter and lithographer, and head of the San Antonio Art Institute; he was also a member and an officer of other fine arts organizations. He was the author of a book *Gas Warfare*, wrote many articles for such publications as the *Saturday Evening Post*, *Scientific American*, *Journal of the American Chemical Society*, and the *Journal of the American College of Surgeons*; and contributed to reference works such as the *Britannica*, *Americana*, and the *Encyclopedia of Chemistry*. Alden was a member of the American Chemical Society, Research Scientists of America and the Society of Mayflower Descendants. He is survived by his wife, the former Kathryn E. Trapp (to whom he was married in 1917); a daughter, Mrs. Betty White; a son, Colonel Thomas M. Waitt; seven grandchildren and four great-grandchildren.

Donald W. Douglas died on February 1, 1981, at the age of 88, in Palm Springs, Calif., his home in recent years. After attending the U.S. Naval Academy for three years, his interest in airplanes led him to resign and enter the Institute, where he joined our class at the beginning of our junior year; he received his bachelor's degree with us in Course II. He then spent a year as an assistant in aeronautical engineering to Dr. Jerome C. Hunsaker, '12, working on the completion of the Institute's first wind tunnel and the first tests in it. Don's name appears with Dr. Hunsaker's as co-author of several reports on that work published by the Smithsonian Institution. In 1915 and 1916 he was associated with the Connecticut Aircraft Co. in New Haven, and in the latter year went with the Glenn L. Martin Co., of which he soon became chief engineer and designed the first Martin Bomber. During World War I Don was chief civilian aeronautical engineer of the U.S. Army Signal Corps for a year and then returned to Martin. In 1920 he moved to California and, with only $600, set up an office in Los Angeles. His strong desire to design and build his own planes was fulfilled when he met David R. Davis, who engaged him to build a plane called the *Cloudster* for a cross-country flight. later, after forming his own company, Don obtained a navy contract for three torpedo planes, and gained financial security.

In 1932 the company entered the commercial field with the building of the *DC-1* (Douglas Commercial) and then the *DC-2*, and in 1936 the famous *DC-3*, which, far more than any other airplane, made possible true commercial air transport, not only in the United Staes, but also in most of the free world. its military version, the *C-47*, was the main transport airplane of the allies in World War II. A total of 11,000 of the two versions was produced; some of them are still flying. The *DC-3* was followed by the four-engined *DC-4*, *DC-6*, *DC-7*, and *DC-8*, giving the Douglas company domination in commercial airplanes for years. Beyond that achievement, the company was the leading manufacturer of military airplanes through World War II and long afterward. Among those airplanes were the *A-20* attack bomber, the *SBD*, the *A-30*, and two airplanes for research.

In 1967 the Douglas company merged with McDonnell Aircraft Corp. and Don retired, as he has long planned to do, with the title of honorary chairman of the board. He was a member of the M.I.T. Corporation from 1958 to 1953 and served on the Aeronautics Visiting Committee in the mid-thirties. In 1965, to mark his 50 years in aviation, the aerospace industry established at the Institute the Donald W. Douglas Fellowship for graduate students in aerospace and related fields. Don is survived by his wife, the former Marguerite Tucker, and by five children by a previous marriage: Donald W. Douglas, Jr.; William E. Douglas; Barbara Jean Arnold; James S. Douglas; and Malcolm A. Douglas; nine grandchildren and two great-grandchildren.—**Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, CT 06119

16 65th Reunion

As this is being written, we're still three months away from our 65th Reunion. As it is being read, we may be packing our bags to go to our 65th. Let's hope that it will be a refreshing experience for all who attend.

Hildegard has written that **Jap Carr** has had medical problems—gall bladder operation and a mild stroke—and made a good recovery following the former and was making progress following the latter. All of us can appreciate the wonderful job Jap has been doing for us as our class agent. . . . **John Gore**'s son, who is a Trappist monk at St. Joseph's Abbey in Spencer, Mass., sent us memorial cards to give to his father's classmates at our 65th Reunion. . . . **Dan Comiskey** called recently to inquire about the whereabouts of **Elsa Mueser**, indicating that he would talk to her about our 65th Reunion. Dan and his wife Grace are doing much better following their recent medical problems and are looking forward to attending our 65th. . . . **George Crowell** sends us a newspaper photo of himself taken on his 87th birthday, which he celebrated during his brief stay in the hospital. He was honored by Brockton Kiwanis Club for being the only surviving charter member of the Brockton Club formed in 1922. George writes, "Everything is O.K. now, and I am looking forward to our 65th at Endicott House, which I'm sure will be beautiful in the spring as it was at the November Luncheon.

We had this newsy letter from **Chet Richardson**: "You probably don't remember me. I was one of the Lynn gang in the Class of 1916. But I remember you as one of the Lowell gang, along with **Ralph Bennet**, **Harold Dodge**, **Howard Hands**, **Bill Liddell** and **Earl Mellen**. For a good number of years there were four of us here in the Niagara Falls area from '16, Course XIV—**Os Mahlman**, **Ray Brown**, **Earl Hauman**, and myself. Also, **Bill Leach**, Course X. They are now all gone except me. I hope to attend our 65th Reunion this coming June. It will be my first in over 50 years. Like most of us, I am in my middle eighties, 86 next June. But due to a very careful choice of ancestor very early in life, I am in excellent health. A few minor annoyances, with lots of pills taken, but nothing to complain about, especially when I see some of my contemporaries in wheelchairs and nursing homes.

Since 1937, I have lived here on a 75-acre farm about 12 miles north of Niagara Falls. My wife died in 1972. We had 48 years together. Two daughters live with me, and a son and his family live in California. He is a structural engineer with skyscraper-building experience. We grow six acres of sweet cherries; 26 tons was the 1980 crop. We rent 45 acres to a neighbor who has raised cabbages, tomatoes, corn, and wheat (only *one* kind of crop per year). One year he sold 400 tons of cabbages to Colonel Sanders' fried chicken people to be used for coleslaw. We keep 19 acres across the road from the house as a memorial to my wife who planted many of the trees that are growing there now. She was an expert greenthumb gardener. I have been spending considerable time over the last two years fighting a poorly run toxic chemical waste disposal firm located about two-and-a-half miles southeast of our farm. I hope, and believe, that my over 40 years' experience in the chemical industry has given me a good background for the fight."

Keep breathing; keep walking; keep writing; keep eating; keep drinking—everything in moderation.—**Ralph A. Fletcher**, Acting Secretary, Groton Rd., West Chelmsford, MA 01863

17

Rom and **Phil Cristal** added to their retirement dilemma when they called on the **Stan Dunnings** at their Havenwood Retirement Community. The problem: how can two go from a 12-room house (in Manchester, N.H.) to a two-room, non housekeeping apartment.

Doris (Mrs. **Bill**) **Hunter** recently returned from a three-week trip to France and Switzerland. She and Bill lived in Zurich when Bill was carrying the flag for the Diell Division of the Singer Co. She had the opportunity to visit numerous friends.

Ray Stevens and **Stan Dunning** attended the Alumni Council meeting on January 26 where they were pleased to have Honorary Member **Jay Stratton** sit with them. Jay and Ray also sat together at the February meeting.

Joseph Littlefield died January 31, 1981, in Miami after a long illness. He served many years as Controller of the Johns-Manville Corp. in New York. Subsequently he was a director of the Research Foundation of the Financial Executives Institute. He graduated from Harvard and two years later got his S.B. from M.I.T. in Course XV. He was a prime mover in the publishing of our *Class of 1917 Thirtieth Anniversary Report*. He was a past president of the M.I.T. Club of New York and always active in M.I.T. affairs. By courtesy of Paul D. Littlefield, treasurer of the Arthur D. Little Co., "He was a rather unusual person in that he raised two complete families. After my mother died in 1950, he married and brought up two additional children, the youngest of whom is Joshua B. Littlefield, currently a senior at M.I.T. He had the unusual distinction of celebrating two 25th wedding anniversaries."

Theordore Z. Haviland died on January 7, 1981, at Ridgewood, N.J. He had been connected with the Dolthen Jute Mills of Paterson before his retirement in 1959. . . . **Allyne C. Litchfield** died on January 13, 1981, at Detroit, Mich. . . . Memorial Services for **James A. Beattie** were held in the M.I.T. Chapel on February 25. He was professor emeritus of physical chemistry, having been in the department for most of his career. A native of Louisville, Ky., he received his B.S., B.M., and Ph.D. degrees from M.I.T., becoming full professor in 1930. Later he was director of the Research Laboratory of Physical Chemistry. Ray Stevens attended the service.

Our 65th Reunion will be held on campus starting on June 9, 1982. So mark your calendars now.—Secretaries Pro tem: **Ray S. Stevens**, 100 Memorial Dr., Cambridge, MA 02142 and **Stanley C. Dunning**, 33 Christain Ave., (Box 218), Concord, NH 03301

18

It would be a great boon to this class secretary if we celebrated four year-end holiday festivals each calendar year. The welcome material in this column

dates back to the Christmas season.

I was really excited to receive this happy note from **Rolf Knudsen** —all the way from Norway: "After M.I.T. I got a job as private assistant to Professor E. F. Northrup at Princeton University, and I worked with him on his high frequency furnace for a year. I had a very interesting time and found a friend for life. Then I went home to Norway and took up work with the family business. We had a small plant making refractories, and I was the manager for many years. When I was 70, a nephew took over the work and still runs that factory with very good results. I live in the country about three hours by car from Oslo and have a very pleasant time here. Best regards to old friends."

Dave McFarland writes from West Chester, Penn.: "Congratulations on your 50th Anniversary. We were fortunate to have our 55th last May and have lived in our home here 53 years. We have a granddaughter in her second year at Boston University who is quite competent in math. I kid her that she should transfer to M.I.T." Dave had a Christmas letter from **Jim Todd** who is retired and has a pacemaker. Of our late classmate **M. T. Sanders**, Dave says, "He was a brilliant and fine person. He must have been with Atlas 45-48 years, as they retained him in a consulting role after he retired."

Paul McGreenery writes from Hanover, Mass., to ask about **Lenny Levine** ("I remember him so well, and he was one nice guy.") and to report that he and Agnes celebrated their 58th wedding anniversary this year. They now have eight great-grandchildren. "About five years back I fell out of a tree while trying to clear out a caterpillar nest. A few days in the hospital and I was as good as new. Agnes said that I should have had my head examined. I told her that I did, but she said she meant before I went up into the tree. About three years ago I had a stroke which cut down on my wandering around. No more raking leaves, shoveling snow, or other disgusting pastimes. I can drive the car better than I can walk." Responding to my rugged individualism question, Paul says, "I think we are committed to a welfare state, but we need more individuals committed to good government and fewer with their hands in the till. This is a great country, and I think that capable men and women will be heard."

Charlie Tavener, 85 years young, begins a new career as executive director of Boca Raton's Community Redevelopment Agency. He writes, "I expect to have an office in the City Hall complex and a part-time secretary. So with at least 30 hours a week on the CBD project, member of three other boards, and dancing lessons once a week, Rhoda complains that I am doing no housework."

Henry Stephens really answered my question about rugged individualism and/or the social welfare state with an entire page of his Christmas greetings. He says, "Ambitious self-driven production and cooperation are more efficient than effort obtained at gunpoint." And: "Money based on gold would encourage the savers and the lenders and would promote prosperity with a ready supply of capital for productive investments."

Harold J. Ryan, '26, sends notice of the death of **Edward A. Mead**, 93, retired from the Nash Engineering Co. of South Norwalk, Conn. Ed graduated in mechanical engineering and was a registered professional engineer in Connecticut.

A notice from the Alumni Office tells of the death of **Harold V. Sturtevant** of Plainfield, N.J., on October 17, 1980. No further details.—**Max Seltzer**, Secretary, 1443 Beacon St., Brookline, MA 02146; **Leonard Levine**, Assistant Secretary, 514 Washington St., Brookline, MA 02146

19

I received a most interesting letter from **Francis Weiskittel**. He is a beekeeper at his home in Baltimore, Md. This amateur hobby came his way when a swarm of honey bees were captured and hived by him. Consequently some years of attention finally produced 19 pounds of honey (note, 19!). Weiskettel also bred Hampshire sheep and a pony on his five acres and topped it off with guineas which he hatched using bantam chickens. Hats off to a kindred classmate. Can someone top him?

An equally interesting letter from **Edmund J. Flynn**. Doc recalls his early days after leaving the Institute when he and other classmates went to work for the New Jersey Zinc Co. in Palmerton. Among those were **Jimmy Reis**, **George McCarten**, **Roy Burbank**, **Gene Smoley** and **George Fleming**. Doc's letter goes into more detail concerning George McCarten, one of our classmates that we all admired. I hope these notes will inspire someone else to recall his early days. Doc and his wife are well.

Now for more recalls, a postcard from **Don Way** while vacationing in Delray Beach, Fla. A highlight of Don and his wife Barbara while there was a 1919 luncheon in company with Jean Smoley's wife (Zwink), Genevieve and **Jack Stevens**, and of course the Ways. A toast was drunk to 1919. All are well.

At this writing and without any details being available I regret to report from the Alumni Office the passing of **S. Albert Kaufmann** in December 1979 and **John P. Comstock** on January 29, 1980. I hope to procure more information for future notes.

Now sit you down and write me a few lines about yourself. Best wishes to you and yours.—**W. O. Langille**, Secretary, Box 144, Gladstone, NJ 07934

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M.I.T.'s new president is hosting a series of dinner meetings at his home for seniors and alumni council members. Alumni talk briefly about their careers and alumni activities in order to make the incoming members of the association appreciate the significance of becoming alumni. I was privileged to attend one of these and must say I was impressed with the quality of these young men and women. Our beloved Institute is in good hands!

The deaths of three stalwart and popular members of the class must be sadly reported. **Bob Ellis** of 417A Chatham Ct., Lakewood, N.J., died on January 17. Gifts to the alumni fund in his memory are suggested. He is survived by his wife.

Mo Lipp of 2545 Lamingo Place, Miami Beach, Fla., died on December 26. Previous class news in the *Review* have described Mo's illustrious career as city manager of Miami Beach. His loss will be keenly felt by his many friends and admirers in this area as well as by his classmates. He is survived by his wife, Helen.

Harold Hedberg of 3333 N.E. 34th St., Ft. Lauderdale, Fla., died on September 22, 1980. Harold lived in Albany, N.Y., where he was an executive of Albany Felt Co. before retiring to Florida.

May I express the hope that those of you who read these notes have survived the winter in good shape and shall celebrate the return of mild weather by writing some news for your secretary.—**Harold Bugbee**, Secretary, 21 Everell Rd., Winchester, MA 01890

21

60th Reunion

A press release from Texas Wesleyan College tells of the award of an honorary doctor of science degree on December 19, 1980, to **Simon W. Freese** of Fort Worth, Tex. Mr. Freese, chairman of the board of Freese and Nichols, got his bachelor's degree at M.I.T. and later studied at the University of Cambridge in England. During his professional career he played a key role in construction of 50 dams throughout Texas. He has supervised the engineering of numerous filtration and sewage treatment plants in the Southwest and at the Colorado River Water District in west Texas. During World War II, Freese served as an economic officer on General Eisenhower's staff. In 1974 the American Society of Civil Engineers honored him with the establishment of the Simon W. Freese Environmental Engineering Lecture. We salute this distinguished classmate!

Via Claudia (Mrs. **Josiah**) **Crosby** I have learned of the marriage of Winnie Wood, widow of **A. Royal Wood**, to Ira C. Foff of Wellesley Hills, Mass., on December 19, 1980. We wish them every happiness.

A brief note from Georgia (Mrs. **Goodman**) **Mottelson** of La Grange, Ill., tells me they have lived in La Grange for 51 years, feel fine, have three children and ten grandchildren. One son is a physicist at the Bohr Institute in Denmark. They spent last summer with the English branch of their family and keep busy with involvement in community affairs.

It is our sad duty to record the deaths of five classmates: **John D. Bowman** of Buffalo, N.Y., on February 27, 1980; **Adolph H. Aronson** of Miami, Fla., on May 28, 1980; **Howard B. Tuthill** of Grand Rapids, Mich., on October 28, 1980; **Merritt F. Farren** of Lakewood, N.J., on November 25, 1980; and **Ralph F. Flather** of Meredith, N.H., on January 14, 1981.

During his career Merritt Farren worked for several New York department stores, was business manager for Old Sturbridge Village, and represented M.I.T. as a member of the Harvard Reconstruction Unit after World War II, serving as an architect for the French government.

I am indebted to Raymond Stevens, '17, for news of Ralph Flather's death and a news clipping. Flather spent his career as an architect, and at one time was a member of the firm of Hutchins and French of Boston. During World War I he was a designer in the ordinance department in Washington.

The sympathy of the class is extended to the families of these classmates.

Your secretary has been in Sarasota, Fla., for the past six weeks and these notes are being written at the end of February just before Betty and I start for home. Our social life is a busy one in Florida including lunches with otehr classmates and numerous cocktail parties. Highlights were: the wonderful Sunday brunch at the Long Boat Key Golf Club at which Millie and **Herb Kaufmann** hosted Claudia and **Josh Crosby** and Betty and **Sumner Hayward**; the cocktail party given by Alice (Mrs. **Robert**) **Felsenthal**; and a final buffet lunch and cocktails given by Claudia and Josh Crosby which included Alice Felsenthal, the Haywards, the Kaufmanns, Beth and **Whittier Spaulding**, Graciela and **Helier Rodriguez** and their house guest, Conchita Lobdell Pearson. The lunch was scrumptious!

Twice during our Florida stay I walked up the beach a mile to call on Kay and **Larcom Randall**, both of whom are having health problems. Larc had to have a leg amputated two years ago and now is in the hospital with fluid in the lungs and bad leg pains. We hope he will be better soon.

Don Morse, reunion chairman, advised me the middle of January that the early returns from the first mailing (up to January 5) showed 31 planning to come (including wives) and 19 more hoping to come. So it looks like a good reunion. Come join us!—**Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, NJ 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Circle, Sarasota, FL 33579; **Samuel E. Lunden**, Assistant Secretary, 1149 S. Broadway, Suite B-800, Los Angeles, CA 90015

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Edward A. Merrill, a Baker Street Irregular for some years, writes from San Francisco, Calif. He has assembled some notes on the unusual methods of Sherlock Holmes in the surveying field, which appears in the *Gaslight Publications*. Ed meets with **Sam Reynolds** for lunch every few weeks. Ed is following the progress of his grandson who received two master's degrees at M.I.T. last June in urban planning and architectural studies and is now busy in the Boston Office of Skidmore, Owings, and Merrill; with Ed's brother (Class '21) and nephew (Class '49) making a fourth to link S.O.M. with M.I.T.

On January 18 your secretary attended a M.I.T. program at Lighthouse Cove in Pompano Beach where *a capella* singers of M.I.T. presented an evening program of humor combined with good music which provided very good after-dinner entertainment. Those in attendance where not classified, but there were about 20 M.I.T. alumni at the dinner. . . . **Oscar Horovitz** is still playing golf in the Pompano Beach area. . . . Your secretary also met people on the *Volendam* who are in a club with **Frank Kurtz** of Delray Beach. Frank is famous in the bridge and

tennis group. Before leaving Lighthouse Point, your secretary hopes to attend one of the local M.I.T. meetings and may visit **Parke Appel** across the state in Venice.

The sympathy of our class goes to the families of **Ward E. Shearer**, Mount Vernon, N.Y.; **Hugh M. Shirey**, Rochester, N.Y.; **Harrison D. Folinsbee**, Cranbury, N.J.; **Herbert D. Allee**, St. Petersburg, Fla.; **Charles E. Brokaw**, Denver, Colo.; Prof. **Warren E. Howland**, Lafayette, Ind.; and **Wilfried M. Thomson**, Glendale, Calif.

An article in the *Norwich Bulletin* tells of our loss during December of **Warren Grant Sharples** of Norwich and Groton Long Point, Conn. Warren worked in the engineering section of the Norwich Gas and Electric Department and was also sales engineer at King Seeley Thermos Co. until his retirement. Warren was a member of the Park Congregational Church, secretary of Norwich Manufacturers Association, served on the board of Norwich Y.M.C.A. and Norwich Chapter of the American Red Cross. Besides his wife, Evelyn, he leaves two daughters.

The news has been infrequent during this period, and we hope to hear from you in greter detail real soon. Happy landings to all.—**Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, NY 14203; **Oscar Horovitz**, Assistant Secretary, 3001 South Course Dr., Pompano Beach, FL 33060

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The *Stamford* (Conn.) *Advocate* notes: "Thanks to **Herman A. Bruson** the Russians were able to defeat the Germans at the Battle of Stalingrad in 1942." Bruson was not in the ranks, but an invention of his in the oil of the Russian tanks enabled them to remain mobile in the frigid cold, while the Nazi tanks could not move. Thus the Russians won the five-month struggle and turned the tide in the Allies' favor.

Phil Coleman, our estate secretary, died January 14 in Bradenton, Fla., where he had moved about a year earlier from Chicago. Phil graduated with our class in business and engineering administration. His first job was a three-year training program with Public Service Electric and Gas Co. in New Jersey, after which he moved to the Illinois Power Co. Finally, after a series of Depression jobs, he moved to Chicago to become associated with Duff and Phelps, Public Utility Financial Consultants, and was made a partner in 1946, a vice-president in 1958, and retired in 1969. He was president of the Alumni Club of Chicago, and was prominently active in the Institute's various fund-raising drives. He gave generously of his time in a number of civic organizations. He was a member of the American Society of Mechanical Engineers, the Union League of Chicago, and trustee and later president of the Western Society of Engineers, and chairman of its Washington Award Commission. . . . **Horatio Bond** has accepted the appointment of class estate secretary to replace Phil Coleman.

Miles Clair died January 23, 1981, at the Cape Cod Nursing and Retirement Home in Lewis Point, Mass. He graduated from Drexel University in 1921 and took a master's degree in civil engineering at the Institute in 1923. Thereafter he was an instructor in civil engineering at the Institute and at Drexel for two years and later was a visitin glecturer at Harvard and Northeastern. He was a naval reserve officer for 14 years and served in naval intelligence operations in World War II. In 1925 he began a 55-year association with The Thompson Lichtner Co., Inc., consulting engineers of Brookline, Mass. He became vice-president of the firm in 1928, president in 1949, and chairman of the board in 1977. His participation in construction problems in involving ready-mixed and precast concrete was worldwide. He was an officer or board member of various professional societies in his field and served on many public service and building code commissions. He was a recipient of the Howard Coonley Medal of the American National Standards Institute, the Bronze Keystone Award, the Man and Boy Award of the Boys' Club of America, the City of Philadelphia's Citation of Achievement and Key to the City, the honorary degree of doctor of engineering from Drexel University, and The Others Award—the Salvation Army's highest award for service to the community and mankind. He was also a 32-degree Mason and a Shriner.

Lucian Jenness died on May 27, 1980. While at the Institute he studied courses in business and engineering administration and later graduated in journalism from Ohio STATE University. He started his career on the oldest paper west of the Alleghenies, the *Scioto Gazette*. From 1933 to 1940 he was employed by the Federal Commission as director of the National Youth Organization in central Ohio. In 1940 he became field representative for the State of Kansas Rural Electrification Authority and developed electric distribution systems for many farms. After some 20 years in public utility work, he became assistant general manager of the National Rural Electrification Authority Cooperative Association is Washington, D.C. as a lobbyist. After retirement he became active with legal problems of the Michigan Diabetes Association and the American Association of Retired Persons.

John Todd died on January 28, 1981, at his home in Mount Dora, Fla. John graduated with our class in architecture. He was associated with the Ferro Concrete Construction Co., Cincinnati, Ohio, as an engineer prior to retirement in Mount Dora. There he was a member of the Youth Club and the Bowling Club.—**Richard H. Frazier**, Secretary-Treasurer, 7 Summit Ave., Winchester, MA 01890

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The ides of March are bearing down heavily on your scribe as you will note from the following lines interspersed with a little good news.

Charles R. MacBrayne died January 6, 1981, in Peru, Fla., after a brief illness. He gained his S.B. in metallurgy and was best known for his role of "Pansy" in the 1924 production of *The HIDDEN Idol*. Beginning his career as a research associate, he rose to be presidnet of Matthiessen-Hegeler Zinc Co., LaSalle, Ill., and in retirement traveled extensively. . . . **George Tapley** writes that his cataract operations was successful and his eyes are in excellent condition. Although his family enjoyed the holidays skiing in New Hampshire, he and Anne played golf in Florida. . . . **Theodore J. James** passed away in Lorain, Ohio, November 8, 1980. He attended M.I.T. after graduating from Colgate University and received a master's from Harvard in chemistry. He was a World War I Army Air Corps veteran and a metallurgist for Westinghouse, later the owner of T. J. James Co., Avon Lake, Ohio.

Ray Lehrer, **Dick Shea**, and **Nish Cornish** attended the M.I.T. Florida Fiesta and report that it was great, especially the talk by our honorary, Prof. **Irwin W. Sizer**. **Don Moore**, **Ed Moll**, **Herb Stewart**, and **Russ Ambach** discussed our June mini-reunion at Woodstock, Vt., at lunch in the Newton-Wellesley Nursing Home where Don is recuperating from a cracked lumbar vertabra. You all should have made reservations at the Woodstock Inn and tendered your deposit check by this printing. . . . **Frank Shaw** is making some progress but is confined to a wheelchair. Would be happy to see any classmates at the Wellesley Manor convalescent Home. . . . **Henry Rau** left us at his home in Florida on January 3, 1981. He earned his S.B. and S.M. in chemical engineering but joined the Westinghouse Lamp Co. In 1930, he established his own business, growing to the present Rau Radio Stations, Inc., Washington D.C. At his death, Henry was board chairman and president. This was interrupted in 1946 for five years while he served as direct assistant to the quartermaster general.

Allora and **Clint Conway**, Clearwater, Fla., plan to attend the mini in Woodstock but will bypass Cambridge this time, as they had attended Dr. Gray's inauguration. They enjoyed a weekend with the **Gordon Harveys** viewing the Atlantic Ocean, a change from the Gulf.

Edith and **George Knight** are wintering in England and will not return until after the mini. They drove to California in the fall and on to Santa Rosa to see Grace and **Stringer Sinnicks**, looking healthy. Proceeding to Phoenix, Ariz., they baked in 106°F., while visiting Frank Knight '23. They were glad to return to the land of the bean and the cod.—**Russell W. Ambach**, Secretary, 216 St. Paul St., Brookline, MA 02146; **Herbert R. Stewart**, Co-secretary, 8 Pilgrim Rd., Waban, MA 02168

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It was nice to hear from **Sam Glaser**, who reports he has retired from active practice in architecture. He now spends about six months of the year in the Boston area and the rest of the year in Palm Springs, Calif. He is available only for consulting work. . . . **G. Colburn Myrick** writes from Delmar, N.Y., where he and his wife Chalotte have resided since 1941. He has been the senior partner since 1958 of Myrick and Chevalier Construction Engineers of East Greenbush, N.Y. He is 95 percent retired but remains active as consultant on water supply and treatment to the town of Bethlehem, N.Y. . . . Captain **N. A. Draim**, U.S.N. Retired, reports as follows from Ventura, Calif.: "At age 80, am still on deck, and although operating on battery power, still active. I am for updating our nuclear missile defense system, but *not* for the MX land-based giant, ten times greated than the Great Wall of China and 50 times larger than the Maginot Line. And look where they are now. I advocate shifting our strategic nuclear defense strategy from land-based ICBMs to seaborne missiles. I also advocate a revitalization of the effort to put together a workable system for the settlement of international differences other than trial by combat. Although more difficult than putting a man on the moon and bringing him safely back to earth, I believe it is possible. We need a crash program at government level, utilizing our best American intellects. Let us put them together, and give them the directive."

More than our share of bad news reaches us through the Alumni Office. The passing of four classmates is reported since the last class notes were written. **Edward B. Alexander** died in Binghamton, N.Y., on November 8, 1980. No details are available. **James N. Andreson** died in St. Vincent's Hospital in Worcester, Mass., on January 17, 1981. James had come to this country from Greece in 1920. He was president of the Worcester Liquor Co. and many years ago founded the Andreson and Paterson Co. He was a past president of the board of trustees of St. Spyridon Greek Orthodox Church and he was a knight of St. Andrew. He leaves a son, Dr. Nicholas J. Andreson of Holden, Mass., and a daughter, Marianne Pappas of Winston-Salem, N.C., two sisters in Greece, and two granddaughters. **Edwin A. Cobb** was stricken while driving his car on December 15, 1980, and was dead on arrival at the Winthrop (Mass.) Hospital. He was a lifelong resident of Winthrop and until his retirement in 1966 was a mechanical engineer with the Stone and Webster Engineering Corp. in Boston. Ed was a commissioner of the Winthrop Water Department for many years, was a member of the Pollution Control Office in Winthrop and was a town meeting member. He was a member of the Point Shirley Associates and an honorary member of the Winthrop Yacht Club. He leaves a daughter, Betty Ann Jaffee of Lynnfield, Mass., and two granddaughters. **Frederick Kranzler** of Kendall Park, N.J., died on November 5, 1980, at the St. Peter Medical Center in New Brunswick, N.J. Fred was employed as a chemist by the Continental Paper Co. of Ridgefield, N.J., until his retirement. He leaves his widow Charlotte (Gross) Kranzler, a son Ted of Mitchellville, Md., a daughter Marian Moyer of Kendall Park, N.J., two brothers, a sister, and seven grandchildren.—**F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

26 55th Reunion

Plans for the 55th at M.I.T. and the Chatham Bars Inn are being finalized. At the committe meeting February 23 **Pink Salmon** sent along cards which, with others received, indicated that there would be about 100 present. There will be an adequate entertainment and sports program on a do-as-you-wish basis. We have heard from several classmates who apparently did not receive the notice mailed in Jan-

uary. If you have a problem in reservations, contact me of Chenery Salmon at Pennswood Village H-114, Newtown, PA 18940. If you need transportation, contact **Bob Dawes** at 50 Houghton St., Hudson, MA 01749, (617) 562-3401.

A letter from **Jim Killian** tells of a recent visit to **Arthur Underwood** and wife at Palm Springs where they spend half their time, the balance in Rochester, Mich. They plan on attending the reunion. Also enclosed was an article in *Tech Talk* about **Stark Draper**'s induction into the National Inventors' Hall of Fame in Arlington, Va., on February 8 for his invention of inertial guidance. The article contains some interesting sidelights on Doc's career including the reference to his visit to Cambridge after having received his first bachelor's degree from Stanford University in 1922, ostensibly to enroll at Harvard. However, on a visit to M.I.T. he became fascinated by the aeronautical department activities and never left, earning his bachelor's, as well as S.M. and Sc.D. degrees.

Abe White called recently inquiring about details of the 55th which he plans to attend. He has been retired and is enjoying life, has four children and four grandchildren, the older ones now attending college. This is a familiar family chronology in our class, characterized by somewhat late marriages in Depression times, and followed by earlier marriages by our children, with a current crop of grandchildren now of college age.

John Wills writes from his Florida address at 5396 Gulf Blvd., St. Petersburg Beach, FA 33706: "I keep busy with many things, and the days seem to pass more quickly than before I retired. When in Illinois I spend more days in a little office provided for me at the Northern Trust than I do on the golf course—for shame! Here I do get my four to six miles of fast walking on the beach when weather permits, and that is almost every day. My interests include helping in the administration of the Graduate School of Banking at the University of Wisconsin, field work with Greenwich Research Associates on matters on value to financial institutions, work as co-trustee, helping in a small way on M.I.T. alumni matters in Chicago, and as much interest as ever in keeping up with what's happening—and trying to guess what may happen—in the business and financial world."

The *Peterborough Transcript* published an article on a showing of watercolors at the Jaffrey Civic Center by **Walter Campbell** of the many and diverse places he has seen in his worldwide travels as an architect. The article refers to his bachelor's and master's degrees from M.I.T., his founding of the firm of Campbell, Aldrich and Nulty and the firm's works, including libraries at Tufts and Simmons, the U.S. Embassy in Taiwan, New England Pavilion at the New York World's Fair, the First National Bank of Boston and the Episcopal Theological Library in Cambridge.

A letter from **Bob Sherwood** tells us that he is now spending more time at his Texas address than in Puerto Rico so mail should be sent to him at 2425 Laurel St., Beaumont, TX 77702. He will join us at the reunion.

Notice of the death of **William W. Dunnell** on December 23 was just received. He was 86 years of age having already had a career before entering our class which included service in the American Ambulance Field Service in France from 1917 to 1919 and receiving the Croix deGuerre for bravery in 1918. He had worked with **Doc Draper** in the Instrumentation Lab, retiring as executive director in 1959. He is survived by his wife Ellen (Frothingham), a daughter, and two sons, and seven grandchildren. Another belated death notice received in January was of the passing of Dr. **Henry F. King** on April 2, 1980, at 3333 N.E. 34th St., Ft. Lauderdale, FL 33308.—**William Meehan**, Secretary, 191 Dorset Rd., Waban, MA 02168

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George Thacher, originally from Ojai, Calif., now lives in Orinda, Calif. From 1927 to 1959 he was a construction engineer on hydro-electric plants for PG&E in the Sierra Nevada mountains. He retired and joined Blake Brothers Co. in Richmond and quarried rock and produced crushed rock products until the business was sold in 1963. In 1964 he joined Parsons-Tudor-Bechtel as a construction engineer on the huge three-mile Berkeley Hills Tunnel of BART. Finally he stopped digging up California, retired "for good" in 1968, and enjoys rest and travel.

Continuing the saga of 1927 aeronautical pioneers, **George Brady**, a graduate student in Course XVI, has made significant contributions. In 1935 he joined Curtis Wright Co. in Buffalo and became involved in efforts to develop the electric propellor. In 1938 he moved to Caldwell, N.J., where he was chief engineer and director of engineering until 1958. During this period, Curtis pioneered many advances such as full feathering, hollow steel blades, reverse pitch and auto synchronization for multi-engines. In 1944-45 he worked with Dr. Robert Goddard to find applications for his liquid propellant rockets.

After 1958 George worked for the Institute of Defense Analyses (IDA) in Washington and became assistant director of the Science and Technology Division. In the late sixties he focused on the possibility of a reusable launch vehicle, and these IDA studies contributed to the STS-Space Shuttle program of NASA. Although he retired in 1968 from IDA, George continues to be a consultant on space technology and particularly performance enhancement. In addition, he is chairman of the Washington City Planning Committee. Congratulations to George.

Dale Stetson was president of the Architectural Society in 1927 and now boasts of being a retired innkeeper in Warren, Vt. He and wife Patricia own the Stetson Inn for skiers who come to Sugarbush. He says it's a great skiing resort area with eight lifts that can carry 6,000 per hour up in the fresh air. February had a brief thaw and rain, but most of the winter was good. It'll be nice there, too, next May when you read this.

Harold (Hal) Edgerton has got the exploring bug again and is tackling the Richelieu River between the St. Lawrence and upper Lake Champlain. It used to be a heavily travelled passage for ships carrying freight between U.S. and Canada and connected with the Welland Canal and the Hudson River. Hal will be using the side-viewing sonar pinger he developed on the Charles River to find wrecks and old wharved along the shore. Several rapids in the river are fertile ground for discovering old "treasures."

Lucas E. (Luke) Bannon reports that he and his wife Louisa moved last February 1980 from Sanford on the East Coast to 19 N. Columbus St., Beverly Hills, Fla., on the West Coast. Luke reports he "feels like a new man" after his cataract removal. "In my case the intraocular inplant was very successful. I haven't heard from my classmates and hope any located near will drop by." (Note: Files indicate Luke retired in 1961 due to failing eyesight, then owned and operated an orange grove until 1973. Plan on coming to our 55th Reunion, Luke!

David R. Knox reports from his home in Lake Worth, Fla., "I am very fortunate to be in good health and able to provide necessary care for Dorothy. I manage to keep constructively busy with my oil painting, providing portraits to our three children from photos when they were two years old. I've also done marine and landscape paintings of New England and a painting of Chartres Cathedral from my 1951 photo. This was accepted as a gift to our church in Palm Beach. We enjoy the leisurely life style of sunny Florida and the county alumni group meetings.

Very belated notice has come of the death of **Walter D. Burger** on December 9, 1979. He graduated Course IV, architecture, and followed his career in Chicago. He never married. He was on the Chicago Board of Education and was supervising architect and projects coordinator for 50 architectural firms and the Board of Education staff. He retired in 1969, travelled extensively abroad, and attended our 50th Reunion. In his will be generously left $15,000 to M.I.T. for the School of Architecture.

Edward Chase died on October 18, 1980, in Plymouth. Ed was one of our most loyal alumni. He attended every reunion but the 40th and has attended every alumni day but two since graduation. He was a civil engineer for the Massachusetts Department of Public Works and retired as supervisory engineer in 1972. He was town engineer for Plymouth and continued as part-time consultant after retirement. He leaves his widow, Helen, two daughters and six grandchildren.

Katherine B. Hunt died the last week of October 1980 in La Jolla, Calif. Mrs. Hunt was the former Katherine Buckingham from Chevy Chase, Md., transferred from Wellesley College, and received her degree in architecture. She married Frederick V. Hunt and lived in Cambridge and Belmont until she moved to La Jolla in 1971.

Warren F. (Judas) Priest died on December 4, 1980, in Farmington, Conn. Judas and wife Ruth (Rusty) had recently moved to Farmington after having retired in 1970 from the Masoneilan International, Inc., of Norwood, Mass. His whole career since 1934 was with this company in various sales positions, and he retired as worldwide sales manager, Petroleum and Chemical Industries. He enjoyed tennis, striper fishing, and skiing and had a wonderful sense of humor.

Ray Hibbert and wife Zella have moved in their retirement to 32 Wilshire Rd., Kensington Acres, Madison, Conn. Our treasurer invites all sailing classmates, including your secretary, to put in to Madison and visit them. Our president, **Harold (Bud) Fisher**, has appointed Ray our reunion chairman, but as this goes to press, his committee has not had the pleasure of reaching Ray and hearing his acceptance speech. We'll print it all when it comes. So, get prepared for our 55th in June 1982!—**Joseph C. Burley**, Secretary Pro tem, 5 Hutchinson St., Milton, MA. 02187

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Every now and then a classmate long unheard from will surface. And so it was with **Henry Simonds** (Course XV, Business and Engineering Administration). Moreover, Henry lives right here in Winchester, Mass., (practically a neighbor) as do several other '28ers. Since retirement Henry has been very busy as a town historian and has made a two-year study involving about 500 historic houses in Winchester. In 1969 he was awarded a Certificate of Commendation from the American Association for State and Local History. His articles on local history are featured from time to time in the town newspapers. Henry was a high school classmate with **Jim Cullen** who is also a Winchester resident. We met Jim recently while shopping and had a pleasant chat with him. Jim's daughter, Franceline (Leary), is an M.I.T. graduate ('55, Course V, Chemistry). Her husband, Eugene, '54, graduated in Course III, Materials Science and Engineering, and their son (our Jim's grandson) graduated last year in Course II, Mechanical Engineering. That's a lot of M.I.T. experience for one family!

We were delighted to have a good informative letter from **Gilbert Toone**. While studying for his Ph.D. at the Institute, Gil worked in the chemistry laboratory, From then on, his entire professional career was with National Aniline Devision of Allied Chemical Co., Buffalo, N.Y., Since retirement Gil has had many activities that keep him well occupied. He enjoys gardening especially and finds particular pleasure in growing gladioli (100 varieties, 500 bulbs) and African violets (60-70 plants, 15 varieties). He refuses to grow vegetables. Gil's other activities include two garden clubs, church. social clubs and a fraternal organizaiton. For some years Gil was troubled with deafness but this finally was almost fully corrected by surgery. Now he and Isabel appear to be in reasonably good health.

As always, we are most happy to hear from our class widows. Marjorie (Mrs. **John A.**) **Carvalho** was pleased to complete her gift of John's books to the M.I.T. Historical Collections. She is well and hopefully we will see her again as we did last year on Technology Day. . . . Iris (Mrs. **Ermano A.**) **Basilio** sent us her New Year greetings. . . . Greetings came also from Judith (Mrs. **Benjamin F.**) **Miller**. Judith does a lot of traveling so we hope she can stop in the Boston area sometime for a visit.

On the occasion of their 43rd wedding anniversa-

ry Dodie and **Ed Walton** write to tell us of their planned trip to Hawaii where they expect to call on **Paul Johnson** and any other classmates they can locate in that area. . . . **Katherine Hazen** reports that, as a widow, her "life alone is taking shape" and that she finds herself extraordinarily busy. . . . A letter from **John Houpis** is Greece tells us that he has been spending the winter in Athens so as to avoid the cold weather at his farm (citrus fruits) in Corinth. He loves the farm and expects to be there all summer. (We hope that John and his family have escaped any harm or damage from the recent earthquakes). John says that he will be 84 next birthday and still feels very good. . . . Claire and **Ted Pierce** mostly stayed home in 1980. Their cheerful letter says that although they do have some ailments they are grateful to be as well as they are. . . . Maxine and **Karl Otte** sent **Jim Donovan** a clipping from the *Chicago Tribune* of Februaru 12, 1981, which was an excellent story about Harold (Doc) Edgerton, '27, and his many interesting developments. It told more about Doc's own life than most of us have ever known. . . . From faraway Japan we have a note from Asako and **Shikao Ikehara** which says, "May the U.S. blosson under the new President!"

With deep regret we must report the deaths of two classmates. **George N. Janes** died on August 24, 1980. The information was sent by his wife. George graduated in Course IXB, General Engineering, and prior to retirement was an electrical engineer with the Naval Facilities Engineering Command. He had three sons. **Clifford L. Webster** died on December 24, 1980. His wife, Esther, wrote and told us that his death was the result of a massive stroke. Clifford studied in Course XVI. His professional work was in aviation and he traveled much of the world. To the families of these classmates we extend our heartfelt sympathy.—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

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Hunter Rouse of Sun City, Ariz., an honorary member of the American Society of Civil Engineers, received the 1980 Civil Engineering History and Heritage Award on October 29, 1980. He was honored for "combining an illustrious career in hydraulics with a lifelong dedication to the study of its history, culminating in the publication of two major works on the history of hydraulics." Hunter was professor of fluid mechanics and consultant as well as a director of Iowa Institute of Hydraulics Research from 1942 to 1966, until he became dean of the engineering college. He has taught at M.I.T., Columbia, Caltech, and Colorado State. He has received several awards from ASCE, including the Norman Medal, the Karl Emil Hilgard Prize, and the Theodore von Karman Medal. Hunter has had many technical missions throughout the world, including Egypt, the U.S.S.R., Rumania, Thailand, Venezuela, Japan, China, Taiwan, and Brazil. He and his charming wife Doi have attended the 25th, 40th and 50th Reunions. Hunter lists as hobbies: engineering history (two books), writing (five technical books and 100 odd articles), travel photography, lapidary (cutting semi-precious stones), and swimming.

William F. Jenkins of Manvel, Tex., lists his hobbies as: gardening, tree farming, landscaping, and maintaining a 20-acre arboretum containing over 120 kinds of trees and shrubs. "My main indoor activity is working acrostics and crossword puzzles. But the hobby I ride hardest is my song writing. Primarily, I write new words for old tunes or write music for old poems. I am enclosing a tune I wrote for a limerick by Oliver Wendell Holmes. Holmes and Jenkins has a sort of a ring to it, don't you think?"

Anthony J. Perry of Moneta, Va., writes, "We are building a new home in the part of Virginia known as Southside, about 30 miles out of Roanoke. The nearest large structure in the area is Smith Mt. Lake." Tony was a hydroelectric engineer working for the Bureau of Reclamation in the Department of the Interior. For the past five to ten years, he has been engaged in consulting work which has involved travel to the Orient (Japan, Korea, Indo-China), South America (Argentina, Bolivia, Brazil, Chile and Venezuela), and the western part of the United States. His hobbies are mathematics, reading, and collecting books on the continental discoveries.

Elise (Mrs. **Warren W.**) **Walker** of Montclair, N.J., sends news of Warren's activities. One of the most exciting recent events was the arrival of Roger Herbert (Miksad), their ninth grandchild. Early last summer, Warren had a sentimental visit from Professor **Chung F. Yee**, who was accompanied by seven other scholars from mainland China to study various advances in American engineering. Warren spent a day with him at Stevens Institute of Technology, gave him a tour of several New Jersey industrial plants, and took him for a ride up the beautiful Palisades and on to West Point. Professor Yee's second son and family have immigrated to America, and another son is entering Stevens in 1981. Warren, a sustaining fellow of M.I.T., and Elise attended the inauguration of our new president, Dr. Paul Gray. Their son Eben also attended as president of the M.I.T. Club of New York. Warren keeps busy 24 hours a day, if not with Grafite (his company) then with the American Association of Industrial Management, of which he is an executive director.

George J. Meyers, Jr. of Wyomissing, Pa., and wife Barbara sent a copy fo their annual letter. George teaches church school and does management consulting; Barbara works in real estate; and they both enjoy tennis visits with their sons and families. Last July their home was broken into by professional thieves who stole, among other things, six oriental rugs. "Another traumatic event was George's falling and tearing the ligaments of his left shoulder. He has started to play tennis again but is serving underhanded." In September, a baby girl was born to one of their sons, Bradford, and his wife, Ann, which brought joy to all 18 in their family. The year ended on a pleasant note: in early December they went cruising with son Bob and family in a 44-foot CSY yacht, which he had chartered. They sailed and snorkeled from St. Vincent's to Grenada and back. Bob was skipper and navigator, while George was helmsman and photographer. It was real ocean sailing with winds from 25 to 50 miles per hour and waves of 12 to 15 feet high."

The 1981 M.I.T. Florida Festival held on February 21-22 in Cypress Garden, Fla., was a huge success. Over 200 alumni with wives and friends attended, representing every class from 1922-1980. Six '29ers with their wives were there, the largest number from a single class. They were: your secretary and his wife, Helen, Elaine and **George L. McKenna**, Mary and **Francis M. Mead**, **H. Charles Pease**, Marian and **Robert S. Pride**, and Helen and **E. Neal Welles**. Credit for this attendance goes to Neal who telephoned a number of us and made hotel reservations. The Dinjians and Prides drove together to Cypress Garden and arrived just in time for registration, lunch, and an informal gathering. Bob Pride met Charles Pease for the first time since graduation—they did their thesis together. Pride, Pease, and your secretary were in Course XVII, now part of Course I. Charlie Pease, who was a fire prevention engineer for Factory Mutual Insurance Co., gave us some professional advice—try to be on the first floor of a hotel and be sure to locate the nearest exit. The highlight of the affair was the Saturday evening cocktail and a delicious buffet. Our new president, Paul E. Gray, briefly outlined the goals and challenges M.I.T. faces in the eighties. He and his charming wife, Priscilla, were enthusiastically received by the crowd. Sunday was a day of relaxation featuring a water skiing show followed by walks through the famous tropical gardens.

I regret to announce the deaths of two of our classmates, **Robert Sutherland** of Treasure Island, Fla., on November 4, 1980, and **Charles W. Denny, Jr.** of Naples, Fla., on January 7, 1981.Charles was a successful engineer and executive. Upon graduation he was associated with Westinghouse for a few years, and in 1932 he joined Barkelew Electric Manufacturing Co., later becoming its president from 1956 to 1967. In December 1967 the company was acquired by Square D Company of Park Ridge, Ill., and Charles became vice-president and manager of the Middletown, Ohio, plant. He retired in 1970 and moved to Naples. He attended the 40th Reunion and had planned to attend the 50th but was unable to because of his health. He was a member of the Moorings Presbyterian Church, Naples Sailing and Yacht Club, Naples Power Squadron, and Naples Orchid Society. He is survived by his wife Lucile and sons Charles W. Denney III and John P. Denney.—**Karnig S. Kinjian**, Secretary, P.O. Box 83, Arlington, MA 02174

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This month's notes are being written in Puerto de la Cruz, Tenerife, where Louise and I are spending one week of an eight-week sojourn in Portugal, Spain, and Morocco, during the course of which we have been exposed to what might perhaps be called the Iberian version of European history, For example, this week's history lesson included a rather intriguing vignette to the effect that Admiral Sir Horatio Nelson attacked Tenerife in 1797 and was soundly trounced by the Canary Islanders.

Through a rather circuitous route, I have received an information sheet distributed by Alex Brown and Sons, investment bankers, recommending the purchase of Haemonetics, Inc. stock which is listed on the OTC. As most of you doubtless know, **Jack Latham** is the founder and board chairman of this company, It seems that at a recently-held conference of the American Association of Blood Banks Jack's company introduced a new product identified as Haemonetics V-50 which performs the following functions: platelet-rich plasma collection, automated plasmapheresis, therapeutic plasma exchange and component collection. If you want to buy a V-50 it will cost you about $25,000. . . . Mildred and **Ed Giroux** continue to enjoy their retirement years with a summer home in Maine and a winter home in Florida. As previously reported in the notes, they are both artists and according to Ed they "must be improving since awards and sales increase." . . . **Bert Whitten** retired from his job with the Boston Gas Co. in 1966. During the years 1966 to 1980 he spent time maintaining property that he and his wife have in Maine, tearing down some buildings and renovating others. The Whittens established Searsport, Maine, as their principal residence but continue to spend part of each winter in Boston. . . . **Daniel Walker** reports that at the time of World War II the U.S. Navy and the Boston Naval Shipyard sponsored an intensive course at M.I.T. in naval architecture for selected engineers. After completing this course Dan worked at the Boston Shipyard for a time and then went to the Bureau of Ships in Washington, D.C., and later to NAVSEC in nearby Maryland. Since his retirement the Walkers have been living in Sun City Center, Fla., which according to Dan has three golf courses, 83 social clubs and about 7,000 inhabitants.

Lou Verveer, at the time of his retirement, was a so-called "elderly housing specialist" for the U.S. Department of Housing and Urban Development (HUD) in the mid-West region, specifically Chicago. Prior to his association with HUD, he worked for many years as an insurance accountant and clerical specialist in Chicago and briefly in Hawaii. The Verveers live in Downers Grove, Ill., where both Lou and his wife are active in hospital auxiliary work, meals-on-wheels, and a local driving corps for cancer patients and others needing transportation. During the course of visits to their family in Washington, D.C., several times a year they always spend an afternoon with Ruth and Irving Dow. . . . **Carleton Vanderwarker** retired as senior vice-president of the American Mutual Insurance Group of Wakefield, Mass. The Vanderwarkers live in New Canaan, Conn., where for the last 10 years Carl has been a member of the town council, which is the governing body of the Town of New Canaan. He is a former vice-president and treasurer of the Country Club of New Canaan and a founder of the Senior Men's Club of New Canaan.—**Gordon K. Lister**, Secretary, 294B Heritage Village, Southbury, CT 06488

31 50th Reunion

Hope to see you all at the 50th Reunion. Although I haven't heard anything further about the reunion since the last class notes, I understand that it will be a bang up affair. Word from **John G. B. Hutchins**

says, "I have been retired as a professor in the Graduate School of Business and Public Administration, Cornell University, since 1975. My wife, Leila, and I have done a good deal of traveling. This winter we will go to Hong Kong to be with my son and his family, returning via Taiwan." . . . **Louis Evans** writes, "Am doing free-lance consulting for Mobil Oil on special overseas projects. Currently involved in developing training plans for several Middle East joint projects." . . . A clipping from the Alumni Association tells that **Dennis M. Robinson**, chairman of High Voltage Engineering Corp., was among the recipients of the Corporate Leadership Awards at the M.I.T. Corporate Luncheon on December 5, 1980, at the Faculty Club.

The M.I.T. Florida Fiesta was a success insofar as the Class of 1931 was concerned although I wish more of you could have attended. Among those attending were Lillian and **Al Sims**, **Bob Martin** and his wife, **Arthur Lappin** and his wife Mae, Louise and **John Swanton**, you assistant secretary, and yours truly. Al and Lillian are still living in Englewood, Fla., but have a new address, namely, 1722 Bayshore St. They will be heading north to Prudence Island about April 15, returning to Florida in October. Although they are still gardening, the cold weather, says Al, really did him in. They are also planning on attanding the Southwest Florida lunch at Casey Key. . . . **Art Lappin** retired in Sarasota and is active in several local organizations, golf, swimming, and participating in the rich cultural life of Sarasota. He retired from Cornell Aero after 24 years. Helen and I enjoyed the Fiesta and are now looking forward to attending the M.I.T. Mexican Fiesta during the middle of March. Incidentally, the Mexican Fiesta was well represented at the Florida Fiesta.

A note from **Larry Barnard** reports that he and Jan hope to leave about April 2 on their way to Longboat Key, Fla., arriving April 16 and staying until May 14 after a visit with Jan's sister and brother-in-law on Marco Island. Larry says that he had lunch with Roslein and **Joe Birdsell** on May 24 in their beautiful home at the top of the headwall of Solstice Canyon in Malibu, Calif. Joe is retired from being a professor of anthropology, University of California, at Los Angeles. . . . On June 8 Larry talked with **Phil Frink** whom he had seen in August 1930 while touring in a Model A. They had a grand trip, were gone for 15 weeks, and covered over 15,000 miles. . . . **Fred Elser** (KH6CZ) and I (AA4AS) are still keeping our ham radio schedules (from Honolulu to Florida) every Sunday evening at 0030 GMT (Universal time) on 21010 KHz using cw and would be glad to have any of our classmates join us. Following our schedule, Fred keeps a schedule with Bob (K4NM) on the same frequency so as to keep up with news from Fred's son. By the time of our reunion, Fred should be receiving his Ph.D.

Deaths reported recently include **Frank M. Baker** on March 5, 1980; **Walter C. Bodycomb, Jr.** on November 14, 1980; **William O. Bruehl** on March 3, 1980; and **Rober M. Price**. No additional information has been received concerning them. Our sincere condolence to their families.—**Edwin S. Worden**, Secretry, P.O. Box 1241, Mount Dora, FL 32757; **John Swanton**, Assistant Secretary, 27 George St., Newton, MA 02158; **Ben W. Steverman**, Assistant Secretary, 3 Pawtucket Rd., Plymouth, MA 02360

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I always knew that **Arthur Marshall** was a man with a wide range of interests and that he could show up almost any place on this planet. Imagine my pleasant surprise when I learned that he was special guest conductor for the Springfield Symphony Orchestra which featured an all-Gershwin program with Don Shirley as solo pianist. A reviewer considered Arthur's first of the program the highlight of the evening. A news article reported that Art Marshall led his own dance band during his student days at M.I.T. and that conducting the symphony was an opportunity for him to relive the happiest days of his life. . . . We have another classmate, **Thomas T. Amirian**, with another unusual hobby. He recently gave a lecture on ancient and rare Armenian coins and stamps at Rhode Island Junior College. . . . **Louis Raymond** writes that he is retired but very active in archaeology. He is doing research on historical "digs."

John Brown participated in the Alumni Fund's telethon. He had the opportunity to talk with several of our classmates and gives us the following report. . . . **Charles E. McCormack** has retired from Dupont. He is married and has four children. He plays golf and hopes to attend our reunion. . . . **Robert Billings** is also retired from Dupont. He is married and enjoying his retirement. . . . **Earl F. Anderton** of Bellevue, Wash., is still active in business as president of Ekono, Inc. He is hoping to attend the reunion. . . . **Bernard M. Markstein, Jr.** is president of AUTO-RAD Supply Co., Inc. in Cincinnati. He has three children and six grandchildren. He and his wife like to travel with the grandchildren. . . . **Herbert Wagner,** Belmar, N.J., is retired from the Army Signal Corps Technical Civilian Staff. He is recovering slowly from a severe automobile accident 18 months ago. Health permitting, he will be at the reunions of 1981 and 1982.

Albert G. Dietz hits the news again. This time he was made honorary member of the American Society of Civil Engineers which held its annual national convention in Florida. Throughout his career he has been engaged in the study of wood plastics and composite materials for building and construction. He has been prominent in the development of high speed testing equipment, true strain extensometers, and basic research on adhesives and laminates. Albert has lectured and participated in engineering missions to some 22 foreign countries.

Richard Berry writes that he noticed the obituary of Quentin Garcia and thought he was a member of our class I don't think he was as I do not have his name on my list. Richard writes further that he was saddened to read of the passing of **Elwood Schafer**, who was his roommate at M.I.T. for three and one-half years. Dick, how about giving us some details about yourself?

We have recently received word that **Earle F. Hiscock**, 77, died on November 23, 1980. He received a degree in naval architecture and ship operation. During World War II he was involved with writing safety regulations. Later as lieutenant commander in the U.S. Coast Guard Reserve, he was responsible for the development of exposure suits, improved life rafts, and other emergency techniques. After 1952 he worked as an independent inventor. His company—KIP, Inc.—held many important patents. he is survived by his wife Alice Carson Hiscock, a son Richard, two daughters by a previous marriage, and five grandchildren.

The Alumni Records Office informs me of the death of **George A. Bisbee** on October 12, 1980. His widow is May H. Bisbee. The office also says **Clarence Renshaw** died on February 2, 1980, leaving his widow Mrs. Eileen O. Renshaw. When we have more obituary information we will pass it on.—**Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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Last December **John Sterner**, vice-chairman of Cordis Corp. in Miami, Fla., was honored by the M.I.T. Corporation with a Corporate Leadership Award—for alumni who demonstrate outstanding leadership in their companies thereby contributing to the strength and well-being of this nation. John, we are proud of you, and wish you well.

Following the tragic loss of Roz and **Ellis Littmann**, I received a fine note dfrom the Littmann's daughter, Susie Littmann Schulte, who told me she received the book, *Exeter Impressions*, that I had sent to Ellis. This is a collection of fine photos of historical houses in and around Exeter, three of which are of Fort Rock Farm buildings. We appreciate your note, Susie. Thaks for the meassage, and may God bless you in your great loss.

Several Christmas cards arrived too late for last issue's publication. Lucy and **George Henning** sent the usual montage of family photos, including some cphotos of their new winter home in Hobe Sound, a charming shore resort north of Palm Beach. . . . We were pleased to get an unusual card from Bobbie and **Bill Harper**. It is roughly the size of *Time* magazine, which may explain the delay in arriving. Their message was touching; they advised my looking ahead and not back, referring to Leona. . . . Prudence and **Horace MacKechnie** wrote to say Horace had suffered a severe heart attack but was responding to treatment. He is now home and is doing the usual slow walking to encourage his recovery. For sure, Horace, be careful and may God be with you. . . . Eileen and **Dick Smith**, of Key Biscayne, are still enjoying good health and are hoping that the 50th will be held at the same spot, Chatham Bars Inn. Dick, that seems assured as of now, only 20 odd months until post time. . . . Katherine and **Carl Swanson** figured their card should carry a message about the fine notes they read regularly; Haw!

Helen and **Art Hungerford** spent early 1980 at Fort Pierce, Fla., renting a condo with a view across Indian River, a large tidal estuary near which the best citrus fruit grows. When they returned home, Art took over the hospital emergency room, and also managed to get in some golf. Then, in September, Helen and Art made a trip to Maine and covered a lot of central New England. They made a stop at Strawberry Banke in Portsmouth, N.H., which is 12 miles from Exeter. My name is in the same phone book. Art, your annual story is most interesting. (Note to all annuals: Please send news in smaller installments and more often so that we can publish most of what you send.)

Werner Bachli's daughter Heidi finished her first year at Providence college, where she is majoring in Portuguese. In addition to the usual—gardening, wood cutting, etc.—Werner managed to get to John's Brook Lodge in the Adirondacks in February and June to again lead AMC. This year for five weeks, he consulted with two groups contracted by GE for enfironmental projects at the Pittsfield plant. The Bachlis are for the most part in good health, though Wern had a touch of bronchitis from which he recovered, and Jeannette had an abdominal disturbance which proved to be negative all the way. Thanks to the Hungerfords and Bachlis, I received a letter from **Frank Bleil** of Visalia, Calif., which contained no news from Frank, but a large clipping from the *Fresno Bee* about **Ara "Steve" Avakian** of Fresno, Calif. About ten years ago Ara wrote that he was about to leave the Aerospace Corp. in Washington, D.C., to go to Fresno in the hopes of teaching Armenian culture at Fresno State University. Now he has written a book (or a pamphlet), the *Book of Chuckles*, which he says is "very basic" to teaching the Armenian alphabet, as well as entertaining to both young and old. Anyone interested in reading the full article about Ara can write me, and I will send him the clip. Ara was a very popular student in our undergraduate years—well liked, good looking, and very amiable. Best of luck to you my, and our, old friend!

We have a fine letter from **Walter F. Swanton.** Walt is retired from Pfaudler, now part of Sybron Corp., and is acting as a part-time consultant on engineering studies for customers. "Last year we joined a citizens' exchange corps for a trip to Helsinki, Siberia, Moscow, and Mongolia, via air and train. Walt enjoyed the scenery, both urban and countryside. Walt mentions two of my old Angus friends, Cynthia and Bill Selden, '30, who still have Angus cattle but are not active with them, spending more time with a theatre project in Rochester. So, hi ya, Cynth and Bill. Walt keeps busy around the house and garden and strives to help Mrs. Walt with affairs domestic. Hurrah for another real benedict. Many thanks, Walt. We appreciate your time and effort.

Walt Skees comes through with a missive of cheer. He suggests that we hold the 50th in September, rather than June, because we started in September 1929. I refuse to go further, but I have Walt's Barcelona address in case of minor rebellions. . . . On a Fund capsule, **Warren Daniels**, a bona fide travel agent since 1975, announces that he and Dorothy have made trips to Hong Kong, China, Ireland, Australia, and New Zealand. It appears that Warren makes some personal use of the agency. . . . That's it for now, fellas and gals. June 1983 is still the 50th Reunion.—**Warren Henderson**, Secretary, Fort Rock Farm, Drawer H, Exeter, NH 03833

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It's nice to be able to start off this month with the information that in December **Harold E. Thayer** was named a fellow of the AIChE for his work in the management and direction of nuclear fuel production. Harold is still the chairman of the board and chief executive officer of Mallinckrodt, Inc. in St. Louis. You will recall that over the years we have mentioned other honors that have come to him for his many professional and civic contributions.

Sorry to say, we have lost two more class members. **George W. W. Brewster** studied architecture with us and graduated from the Harvard School of Design in 1936. He was active in the Boston area and became a fellow in design of the A.I.A. in 1957. Mr. Brewster was also an able artist and in 1965 closed his Boston office to devote more time to painting. He is survived by his wife Joan, three sons, a brother, and seven grandchildren.

Bob Roulston sends a clipping concerning the death of another classmate. On January 30 **"Jinks" Callan** died in Norwood Hospital after a long illness. Over the years he had worked with Bigelow, Kent, and Willard Engineering Co. and Foxborough Engineering. He was a past vice-president of Knox Co., and he retired last year after spending five years with the National Marine Fisheries Laboratory in Gloucester. Jinks leaves his wife Catherine, a daughter living in Anchorage, Alaska, and two sisters. He was a faithful "reunioner" over the years, and we will miss him.

To both Mrs. Brewster and Mrs. Callan and their families I extend the sympathy of our class.

In his note Bob added that while he was visiting his son in Houston at Christmas, he had a chance to visit Irene and **Ed Asch.** Ed is still working as a consultant for the Sentry Systems, Inc. on various hydraulic control systems. He is also tasting the joys of semi-retirement and travel. Bob says he and Ed spent quite a while exchanging notes on their trips to England and Italy.

I have one very newsy Alumni Fund note from **Ed Geittman** who writes, "Mary and I usually take a trip a year. Last year it was the Holy Lands and this year it was China, from which we just returned. My only comment is 'Unbelievable!' They are attacking their overpopulation problem by limiting families to one child per couple. (The second one would get no 'coupons.') Everyone dresses alike and owns nothing except a few clothes and maybe a bicycle, radio, small TV, camera. Everyone works. The Iron Horse is still king of the road, except that the crack main line trains are dieselized. You look at those city buildings, usually in poor repair, and realize they once belonged to private interests but now belong to the People's Republic of China. One wonders what the owners got out of the deal.

"I notice retirees frequently look for a business to take on. Since I've had this little company in the metal alloy business for 32 years, why not hang on? C'mon—let's hear from some of you fellows who haven't written in." Needless to add, I say "Amen" to Ed's last comment. Also, it is interesting to see how many people are now taking trips to China, since it's now open to visitors.

Just to show that New England hasn't changed—last issue I commented on how cold December and January had been. This is written on February 20, and this past week temperatures in Boston got up to 67°, an all time record! Well, I don't care. In 48 hours I'll be on the *Volendam* bound for 12 days of Caribbean sunshine. I'll tell you about anything interesting next issue.—**Robert M. Franklin**, Secretary, 620 Satucket Rd. (P.O. Box 1147), Brewster, MA 02631; **George G. Bull**, Assistant Secretary, 4601 N. Park Ave. Apt. 711, Chevy Chase, MD.

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I will start by passing along to you some notes received through the M.I.T. Alumni Fund. **Philip H. Rhodes** writes, "I have finally retired (as of November 1) from Custom Coated Products (acquired by Dayco Corp. in December 1979) where I was technical director. Have been retained in consulting capacity. Looking forward to the house and yard-work I haven't had time for. Also hope to make at least another vacation in England. Last summer crossed again on the *QE-II* and then spent one week on a canal boat out of Stoke-on-Trent—perfectly delightful." . . . **Samuel H. Brown** writes, "Natalie and I just returned from two weeks in Spain and a subsequent two weeks in Italy. No golf, but a splendid holiday." . . . **Alexander F. Hamilton** notes, "Member of Clearwater Country Club—play golf Monday, Wednesday, Friday, tennis on Tuesday, Thursday, Saturday. Tough life this retirement!"

Here's some exciting news from **Harold H. Everett.** "Through great good fortune, found a lovely widow, the former Florence Stephan Lacy, who accapted me in marriage September 6. Expect now to retire January 1, 1981, but will retain my corporate "envelope" (Everett Marketing Corp.) for possible future activity as industrial marketing consultant." . . . News about **Rollin D. Morse** comes form a copy of the Lancaster County Redevelopment Authority newspaper *Across the Fence.* Rollin is one of the organizers of the revitalization movement of Columbia, Pa. He is also a member of the local historical society and secretary of the LCRA.

Phyllis and **Charles Debes** updated us on their family activities but first wanted us to know how much the card signed by 45th Reunioners was appreciated. They couldn't make it because Phyllis fell and broke her leg. She's fine now, but full recovery was a slow process. Daughter Marybrent Debth presented them with a second grandchild, Trevor Charles, born April 18, 1980. Trevor's older brother, Trenton, is 2. Daughter Cheryl continues her work in Chicago with *Business Week.* Daughter Robin lives with her husband, Kim Tipton, in Minneapolis where she is a banking service representative for the First Chicago Data Corp. Charles has been busy with Park Strathmoor and Alma Nelson Manor, nursing homes, and trying to get one going in Key West, Fla.

Arthur L. Haskins tells us what his two are doing: son, Dan, has a master's in mechanical engineering from M.I.T., is single and head of the ME Department at Franklin Institute, Boston. Daughter, Carolyn, has her master's in education from Colorado State, teaches in Broomfield, Colo., and lives on spectacular Sugarloaf Mountain in Boulder with her husband, Wayne Roth. All three come East each summer.

I regret to advise of the death of another of our classmates, **Charles H. Kolker,** of Verona, N.J., who died in 1978. He was president of Montrochem Dev Corp. of Newark. I am extending our sympathy to his widow.

Bernie Nelson, after discussions with some of us in the area, decided we would forego our mini-reunion June 5, 1981. However, if you plan to be in the area, please let me know so we can arrange something.—**Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, MA 02160

36 45th Reunion

Recognizing that you may be reading these notes just before our 45th Reunion, I want to suggest that it's never too late until the affair is over. Try to be at the Institute on Thursday and Friday, June 4-5, and at the Wychmere Harbor Club for the weekend following.

Bernard Gordon writes that he retired in 1979 from Woodward Clyde Consultants (Western Region) in Oakland, Calif., and that he is currently operating as an independent consultant in the fields of embankment dams and geotechnical engineering. He notes that his family consists of his wife, Dottie, and two Brittany spaniels (both girls). . . . Word has been received from his widow of the death in September 1978 of **Sterling A. Clark** of Roxboro, N.C. I have no further information and can only report that he formerly lived in Rumford, R.I. Mrs. Clark's address is 403 Ridge Rd., Roxboro, NC 27573,

It is with a profound sense of sadness that I must report the death from cancer of **Rufus P. Isaacs** on January 18, 1981, in Baltimore. Rufus was professor emeritus of applied mathematics at Johns Hopkins University. Prior to joining the Hopkins faculty in 1967, he was a mathematician for the Rand Corp. I have previously reported to you that the *Journal of Optimization Theory and Applications* published in January 1979 an issue dedicated to Rufus. His specialty was differential games and his book with that title received the Lanchester Prize of the Operations Research Society. He earned his master's and Ph.D. degrees at Columbia University, where as a graduate student he illustrated a book, *Mathematics and the Imagination*, written by his professor. He had attended the Art Students League in New York City, where he was born; he has painted, done ceramics, and more recently sculpting. Rufus is survived by his wife, Rose, of 1418 Mason St., Baltimore, MD 21217, and two daughters, Dr. Ellen Isaacs of New York City, and Frances Conrad, of Washington D.C. To them all our deepest sympathy. Rufus will be missed greatly.—**Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, CT 06091

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Norm Birch writes that 1980 was an exciting year for them because they acquired two new grandchildren. Elizabeth Anne was born to Judy and Eric in England on February 6, joining her brothers, Alex (9) and Jordan (6). Three weeks later Eric brought his family home to Corning permanently, adding to their joy. On September 28 Cathy and Alan gave 18-month-old David a baby brother, Steven Philip, and the grandparents went to Corning to help them for the first week of October. Norm and Elvie's 40th wedding anniversary occurred while they were there, and the families made a memorable occasion of it. Then Norm and Elvie celebrated further with a ten-day plane trip to Lake Worth, Fla., and stayed with old friends for a restful and relaxing time. They were back home to spend Thanksgiving and Christmas with the family.

Dick Young retired at the end of 1980 and moved to a new home in Newport, R.I., so as not to be too far from Wellesley and Boston. Newport has all the Cape's advantages and is delightful. His son Dick moved there four years ago to be nearer Debbie's parents. It made no difference to Dick's business because he simply set up down there to publish his *World Money Forecast.*

Joe Heal writes, "Marion and I are thoroughly enjoying our retirement. We spend sex months here in Long Boat Key, Fla., spend spring and fall in Massachusetts and the summer in Maine. The weather has been delightful with most every day in the 60-80 degrees range for December, January, and February. Yesterday I sang the *Messiah* with the Sarasota Choral Society in the Van Wezek auditorium which holds 2,000. Since there were 170 in the group, most coming from local church choirs, they made an impressive sound." . . . **Joe Smedile** writes, "The biggest news about the family was the birth of our first and only grandchild, on March 12, offspring of Pam and Gary. We left Wilmette, Ill., in June after living there for 16 years. Enroute to Florida we drove to San Antonio, Tex., for Tommy's christening, with Martha as the godmother." They moved into their new home in late December. The house is relatively small and is directly on the Intra-Coastal Waterway. Martha and Joe are doing fine and will both have to pick up the pieces and start over again with new friends.

Phil Peters retired from John Hancock after 42 years and is looking forward to new freedom and opportunity. World Affairs Council and the Boston Symphony continue high on their activity list. They have had a busy 1980 with trips to Europe and the Far East, plus various way stations. The high point of the year was the birth of two new grandchildren. Jessica, born to oldest son Pete and his wife Tamie on October 1. On October 14 Andrew Bell Peters was born to his second son Greg and his wife Diane. They now have seven grandchildren in all. Pete and Tamie still live in Armonk, N.Y., and Greg and Di thoroughly enjoy their Shelburne, Vt., home. Jeff, their youngest son, continues unmarried and is still executive director of the U.S.-Mexico Quadripartite Commission, shuttling frequently between New York and Mexico.—**Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, MA 02155; **Lester Klashman**, Assistant Secretary, 198 Maple St., Malden, MA 02148

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Harry Saunders has migrated to Seattle, where he is ensconced in a condo right on Puget Sound. Visitors are always welcome, except when he occasionally goes back to Illinois on farm business.

Russ Coile spent last year in Rio, where he worked on operations research for the Brazilian Navy on logistical problems of some new frigates. He says that he was more successful in learning to play soccer than in learning to speak Portuguese.

Dave Wadleigh and your secretary both belong to the Chatham Retired Men's Association, which meets on Fridays, fall through spring. Lo and behold, unbeknownst to us **Matt Abbott** was inducted as a member. Like Dave and myself, Matt has retired to *the* retirement community of the northeast. With three of us here, Chatham may have the largest contingent of '38ers.—**Armand L. Bruneau, Jr.**, Secretary, 663 Riverview Dr., Chatham, MA 02633

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Natalie and **Dick Martin** just flew from Marblehead to San Diego to visit their son. Said son furnished his classy Fiat convertible roadster, and they drove over to share with Hilda and me a fun lunch, our ocean view, and some news items. Dick continues his career at Polaroid and is active in his community. His latest extra-curricular effort was to help raise $38,000 to re-work the Student House. Dick relayed news about three classmates. Sybil and **Bob Saunders** reside in Atlanta and plan to swap houses and sailboats with the Martins for a week or so this summer. **Jack Hamilton** continues his work in the mahogany halls at Wearever Aluminum Co. in Pittsburgh. **Howard Marshall** retired last year from Newport News Naval Station and continues to reside in that area.

Morgan Sze accepted assignment as vice-president for technical development in the energy division of Wheelabrator-Frye, Inc. Morgan holds 77 U.S. patents and he is known for his successes in developing new process technologies. This news item is especially interesting to me because, during 1960, Morgan and I worked for different companies, but we came together with the common mission of placing in operation Korea's first synthetic urea plant, at that time one of the world's largest single-train units.

Albert Waters accepted assignment as building inspector for Topsfield, Mass. During 1978 Al was project manager for the expansion of the International Airport at Riyadh, Saudi Arabia.

George Morrison spent his entire career since graduation with Turner Construction Co., except for five years in World War II service. George just retired as vice-president and operations manager and established residence at Old Bennington Rd., Greenfield, NH 03047, where he expects to have time to respond promptly to all classmates who write or are in his neighborhood. . . . **Gordon Holbrook** retired after 34 years of service in the gas turbine program at the Detroit Diesel Allison Division of General Motors. Gordon and Elizabeth moved to Arizona where they enjoy life and do some consulting work in aerospace and industrial gas turbines and some guest lecturing in aeronautics and astronautics at M.I.T. . . . **Art Curtis** is in his fourth year of retirement at Colchester, Conn., and he recommends it.—**Hal Seykota**, Secretary, 1421 Calle Altura, La Jolla, CA 92037

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An interesting letter from **Joe Greenberg** indicates that since his retirement in January as an officer of A. T. Kearney, Inc. he has been acting as a consultant to the company in their government group, specializing in energy conservation. he has also worked in Egypt as a consultant on steel plant and pipe mill programs. this fall he will teach a course in industrial furnace design at Illinois Institute of Technology. I think he said he had retired?

Phil Stoddard, who retired last year as vice-president of operations of M.I.T., was unanimously elected as the new chairman of the board of the M.I.T. quarter century club at a board meeting in January.

Russ Haden writes that he and Nancy enjoyed meeting with old friends at the 40th reunion last June. they are looking forward to the 41st. after much perseverance, the company which he acquired sevral years ago, which manufactures adhesives, has now turned the corner, and he looks forward to a profitable future.

Jack Danforth sends a news clipping indicating that not since Orville and Wilbur Wright have brothers made such a splash in the aircraft business as our own **John J. Casey** and his brother, Albert V. Casey. John, as reported previously, was elected chairman of the board, president, and chief executive officer of Braniff in January. seven years ago his brother Albert was chosen to head American Airlines.

Received an interesting note from a young schoolteacher who has become a fan and collector of information regarding the late band leader, Glenn Miller. he is compiling, in book form, an appreciation of the Miller saga and wants to include the great appeal which he had for the college crowd—our days! his research indicates that Miller played at the M.I.T. field day dance on October 28, 1938 and also for the sophomore dance in 1937. He had acquired the names of the field day committee members—**Hap Farrell**, **Ed Wallace**, **Norm Klivans**, **Ed Crosby** and **L. Hurley Bloom** — and plans to get in touch with them. however, he would also like to have the names of those '40 grads who planned the sophomore dance. please come forward, if you remember. he is also interested in receiving snapshots and any of your memories of this event. write to him; Glenn D. Mittler, 41734 Edison Ct., Elyria, OH 44035.

I am sorry to report the death of Rear Admiral **James R. Z. Reynolds**, U.S.N. retired, in Gales Perry, Conn., on September 22, 1980. a graduate of the U.S. Naval Academy, he received a master of science degree in marine engineering from M.I.T. during World War II he served with the submarine force in the Pacific, receiving the Bronze Star Medal and the Commendation Ribbon with Combat V. Retiring from the navy in 1958, he spent the next 13 years with General Dynamics-Electric Boat, supervising construction and repair of nuclear-powered submarines. he is survived by his wife Mary and one daughter.

A note, with an alumni contribution, from **C. Herbert Wheeler, Jr.**, indicates that he is now professor emeritus of architectural engineering at Penn State University, University Park, Pa.—**Donald R. Erb**, Secretary, 10 Sherbrooke Dr., Dover, MA 02030

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Charlie Lawrence was in Amman, Jordan from June until December of 1980 doing a report on the Jordan water needs. An article on his survey appeared in the *ASCE Journal* for March 1981. . . . **Fran Staszesky**, president of Boston Edison Co., has just been elected chairman of the Atomic Industrial Forum in Washington, D.C., a professional association of executives interested in atomic energy.

Pete Volanakis has been elected a corporate senior vice-president of the Hammermill Paper Co. in Erie, Pa. He continues as president of the Hammermill Papers Group and will have some additional duties. . . **Al Hayes**, who retired from Lockheed Missiles and Space Co. five years ago, just marked his 50th anniversary as president of Albert Hayes and Associates. Al is doing reliability engineering for a number of electronic firms in California, Arizona, and Nevada.

Art Power sends a short note telling us that the Class of 1942 had a mini-reunion which lasted about ten minutes in the parking lot after a meeting of the Fairfield County M.I.T. Club. It took them that long to congratulate one another on "our wisdom in having attended M.I.T.!" Those attending were **Ed Smith**, **Hank Lemaire** and Art.

"**Hank Shaw** has been our most interesting and most voluminous correspondent. In addition to commenting on all kinds of doings in the Massachusetts and New Hampshire areas, he is the conduit through which we get information about **Bob Rines**. Bob is still struggling to keep his Franklin Pierce Law School going and growing. The last paragraph of Hawk's recent letter is worth quoting: "I retain membership in a number of labor unions having to do with my trade. My local is the Boston Surgical Society. Then comes the New England Surgical Society and the American College of Surgeons. We work closely with like labor unions. Closest to us are the pathologists who get our mistakes as do the morticians who are very well organized. We all pick up data. Historians try to put it together!" And now my editorial note: class secretaries write it up, usually several months too late.—**Ken Rosett**, Secretary, 191 Albermarle Rd., White Plains, NY 10605

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A letter from **Dick Feingold** welcomed me as his successor class secretary (he had served only 27 years), told of his move from West Frostbelt, Conn., to Palm Springs, Calif., and reported on his professional activities of the last five years. He has been a consultant to Connecticutt's attorney general in the defense of two $30 million lawsuits arising out of the construction of the University of Connecticut Medical School Health Center. Many fascinating details are contained in a Hartford newspaper article, which I'll send to interested parties on request, Dick claims to be the youngest member of the class, but I am his junior by 48 days. Anyone else want to enter the contest?

Al Emond, former chemist, now develops real estate in the San Diego area. Si, senor, the condos, they are English Tudor. . . . **Lou Geyer** has a farm, possibly in Scituate, Mass., where he raises pigs and enough hay to require a baler. He and his wife Barb recently returned safely from a visit to the Irish Republic. . . . Another impressive news story reports the election of **Bill Thurston** as a new director of the National Association of Manufacturers. Bill, a course VI grad, is president and CEO of GenRad, Inc. of Concord, Mass. Bill started his career there in 1943, when the firm was called General Radio Co., and always took the back cover ad in the *Review*.

As of January 9, your secretary is enjoying his first grandchild, but from a distance. The kid lives in Edinburgh, Scotland, and don't get to see her until April.—**Bob Rorschach**, Secretary, 2544 S. Norfolk,Tulsa, OK 74114

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Once again we have arrived at that time of year when we are asked to make, if we have not already done so, a contribution to the M.I.T. Alumni Fund. There can be no doubt that because of our M.I.T. education, we were offerred career opportunities not open to all. Some of us started our own businesses which provided jobs for us and others. It seems to me, in these days of increasing costs for education, part of it brought about by the rising costs of hiring and keeping the highly qualified staff of M.I.T., that we have an obligation to give our financial support to keep the Institute going for us and for future students. Your contribution, generous we hope, will be credited to our class gift to be presented at our 40th Reunion in 1984. **Norm Sebell**, our class president and former class agent, is working hard to find someone to be our class agent. When this happens, perhaps I can sit back and just report the class news.

Did you know that **Holton Harris** holds an Amateur Extra Class license plus a first class radio-telephone commercial license? He received his first ham radio license while in high school in 1939. Last fall Holton spoke of his hobby and the rewards it can bring to a group at the Westport, Conn. YMCA.

George Devoe, who is an independent insurance agent, was selected to appear in a documentary film produced by the Hartford Insurance Group. He noted how interesting and fun it was to be followed about by a cameraman, film crew, and director for

two days in order to capture the typical agent's work day and leisure time. George, along with his wife, Claire, and daughter, Daniele, also found time to meet and dine with Jose Ferrer, who narrates the film.

Arthur F. Dershowitz adds to his Alumni Fund envelope, "Still with General Electric Co. in corporate planning although year-to-year variation in type of work is quite large. Presented a couple of statistical papers to AACE and ASQE last year since I was doing chemical engineering rather than statistics at work."

Macroengineering was the subject for a recent meeting of the Boston Seminar Series. The problems of setting up "Jubail" in Arabia were presented. In addition, the problems and plans associated with the space shuttle program were presented. This was most timely, as the engines were publicly tested two days later.

Let's plan to have dinner together on Technology Day, June 5. See you there!—**Melissa Teixeira**, Secretary, 92 Webster Pk., West Newton, MA 02165

45

Before we continue with our 35th Reunion comments, let's get caught up with the correspondence, particularly Christmas 1980. Another **Sheridan Ing** family wedding. If memory serves correctly, the '78 card also had a wedding picture. Julia's brief note remarks on the great time had at our 35th. . . . A pleasant card from Jean and **Chris Boland** which can now serve as a reminder for the 1981 Alumni Fund! . . . Jan and **Charlie Patterson** commented that they wished they were at a southern facsimile of the Snow Inn! . . . Best wishes from past prexy 1970-75, **John McNamara**. A reminder from Ellen and **Jim Brayton** of Little Compton, R.I., that it is time for dinner again! A note from Norma and **George (GB) Hetrick** that they moved across town in Lancaster, Pa., last spring.

In lieu of cards, we had two pleasant phone calls. One Christmas Eve **Julian "Buzz" Busby** called from Oklahoma. Son Jeff, another wildcat type, has formed a company with two partners and has gone public. Also, George (named for Hetrick above!) et al were living in Aberdeen, Scotland, as George is a Chevron drilling engineer in the North Sea. Ten days later, a call from **Vince Butler** advised us that son Buzz (yes, nicknamed for Busby above) had just scored 30 basketball points against Stanford. Vinnie was so excited you would have thought he had scored the points! . . . A note from **Tom Stephenson** says that Alcoa, after 35 years, has made their son a vice-president, construction, and Tom modestly adds that this has made some change! Both the boys are married, but no grandchildren. T.I. continues to travel with Brazil and Australia as regular stops.

J. J. Strnad had an interesting question on our reunion questionnaire form. J. J. asked the difference between the words "plan" and "hope"; and then added that if one plans, one also hopes, and vice versa! . . . **Thomas A. Hood** must continue in the granite business if his Brandon, Vt., address is indicative. . . . **Ralph P. Cromer** is still with Sierra Pacific Power in Reno, Nev. . . . Other individuals who responded with class dues: **John H. Cullinan** of Pocasset, Mass.; **Edgar Andrews** from Mountain Brook, Ala.; **William Y. Humphreys,** Shelby, Ohio; **Ray Pelley**, Cincinnati, Ohio; **James C. Smith,** Tokyo, Japan; **A. Franklin Hahn**, Berwyn, Penn.; **Alvin S. Cohen,** New Rochelle, N.Y.; **Curt B. Beck,** Cabot's own from Pampa, Tex.; **Robert E. Harris**, Seattle, Wash.; and **J. Spencer Standish**, vice-chairman of Albany International, Londonville, N.Y.

Nick Mumford reports that he is enjoying his Vought retirement while working part time for his Episcopal bishop as his assistant for financial report. I would interpret that statement to mean that Nick is the official arm twister! Nick looks forward to visiting the grandchildren this spring, and we hope he can squeeze New England into these travels. . . . A note from Lou and **Pete Hickey** advises us that it is time to get together for bridge. We always enjoy our card, note, and family picture from Lisa VanCitter, Pete and Lou's oldest. . . . And we can not forget Bille and **Al Bowen** or Trudy and **Max Ruehrmund**. . . . **Jerry Patterson** is back working in fort Worth and would have been at our 35th if the Dallas steel fabrication firm he was then managing had not been sold! The Patterson's youngest, Liz, has finally moved to Texas as a process engineer at Texas Instruments. Liz has a B.S. in chemistry which suggests that she is not following in her father's footsteps. Son Mark and Donnie plus two live in Rochester, N.Y.; Rob clings to life in New York City while Lawyer Tom and Mary Lou plus three are in Dallas. Wife Libby is busy managing a stable.

Your secretary remembers Mary's wrath! And thus, I shall report on the **Jim Hoaglunds**! Son John and family continue to enjoy California where John is head of an Aetna Task Force on asbestosis. Judy received her M.S. in nutrition in June and is now in Chile running a demonstration farm as a Peace Corps member. Classmate Jim has his hands full running 11 U.S. manufacturing plants plus additional in Brazil, Mexico, and Italy for the McQuay and Perfex groups. Mary has become somewhat disenchanted with the work standard at the Minnesota Department of Education—presumably, a typical bureaucracy! Yes, one must conclude that Jim and family are thriving!

Last month we mentioned **Jim Shearer's** '78 activity; this year is working mirror fusion. He reports that one of his sons is in the mathematics department at the Institute while the other is with the U.S. Coast and Geodetic Survey in California. Wife, Gail-Marie, continues her interest in low-income housing. . . . A report on the **Thomas A. Hewson** family: daughter Joan works at Olin in Stamford, Conn., in chemical marketing. Son Tom, Jr. (Princeton, '76) is in environmental engineering with Energy and Environmental Analysis in Arlington, Vir., while son Ted (John Hopkins, '78) is at Cornell working towards a M.B.A. in hospital administration. Betsy is busy with tennis, needlework, music, and occasional boating. Classmate Tom's prime interest these days is microelectronics and its application in opthalmology, particularly in the diagnosis of eye disease.

Hopefully, we will return to our 35th Reunion notes next issue.—**Clinton H. Springer**, Secretary, P.O. Box 288 New Castle, NH 03845

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Ed Frohling founded Mountain States Mineral Enterprises, Inc. in 1970 with five employees. Today Ed's company has 300 employees at its Tucson, Arlz., headquarters and 900 specialists and construction workers worldwide. Ed's company is the 26th largest exporter of U.S. mining technology and provides complete services. Beginning with early assay reports on an area's potential they can also engineer, construct, and manage complete facilities. At present 40 percent of Mountain States' projects are overseas.

M.I.T. presents Corporate Leadership Awards to honor individuals whose responsibilities in private industry mark them as exceptional contributors to the continued strength and well being of private enterprise. The presentations began in 1976, and this year's recipients included four of our classmates: **William P. Murphy**, chairman, Cordis Corp., Miami, Fla.; **Peter M. St. Germain**, managing director, Morgan Stanley and Co., New York City; **Davis P. Thurber**, chairman, Bank of New Hampshire, Manchester, N.H.; and **Robert H. Welsh**, vice-chairman, Ludlow Corp., Needham Heights, Mass.

Mike Kami conducted a seminar on "Managing the Uncertain Eighties Post-Election Survival Strategies" for the President's Association. Mike discussed specific concerns raised by CEO's around the country who were surveyed by the President's Association as to their most pressing planning problems. To obtain workable solutions to these problems, Mike showed how unconventional ways of thinking such as the pyramid thinking process could be used. He discussed how productivity can be increased through automation and motivation—if you know where and how to use them. He presented adaptive management as a way to reduce your response time and help make the right moves in time for them to be effective.

Frank Jones is president of Dietz Forge Co. He was recently elected a director of the Federal Reserve Bank of St. Louis. . . . **George Keller** is now chairman and chief executive officer of Standard Oil of California. . . . **Albert Bryan** was named vice-president, corporate development, group for Raytheon's government group.—**S. Martin Billett**, Secretary, 16 Greenwood Ave., Barrington, RI 02806

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Plan to attend the buffet dinner for all '49ers on Thursday, June 4, just before the Pops (sentimentally, we miss Fiedler but John Williams does make memorable music). . . . Shortly after Technology Day, specifically on June 20, **Lou Peloubet** will probably be marching down the aisle with his daughter Anne. Lou is controller of Union Carbide. . . . **Charles (Chuck) Holzwarth** calls himself "the low profile guy" at Rockford Metro Center. But the fact remains that Holzwarth, chairman of the Metro Authority Board, ushers into being a facility that has been dreamed about, thwarted, revived, revised, placed on hold, debated, deferred, and (now, finally) delivered to the fun-loving public. The birth pangs lasted 63 years. Holzwarth's assistance in the delivery spans the last three years and seven months." So said the "We Salute" column of the *Rockford Register Star.* Another who knows him well said of Chuck, "It has not been easy, but Chuck thrives on this type of challenge. One of the advantages of living in a city this size is the chance to become involved in the community—to make a difference." Such justifiable pride in that statement! Thank you, Shirley, for telling us about the accomplishment of our classmate and your husband. Congratulations, Chuck, for making a difference.

Robert C. Peterson vacationed in Germany last summer and had a combined family/M.I.T. reunion with sons Jeff, '76, and Andy, '78, who were both living there. . . . **William McDonald** has celebrated his 30th year with duPont. He is an engineering associate in plant design at Martinsville, Vir. . . . **William Atkinson** has recently retired from Electric Boat after 31 years. . . . **Orlien Becker** is president of Pacific Technology, Inc.

Three of our classmates were among those presented Corporate Leadership Awards by Howard Johnson. They are **Marvin Asnes**, president of Becton, Dickinson Co.; **Alex D'Arbeloff**, president of Teradyne; and **George Hatsopoulos**, president of Thermo-Electron Corp.

Your class secretary has moved. My new address, until the family moves here to St. Louis, follows.—**Paul E. Weamer**, Secretary, c/o Cambridge Engineering, Inc., 17825 Chesterfield Airport Rd., Box 1010, Chesterfield,MI 63017

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Mariano A. Romaguera, is already making plans for the 35th Reunion in 1985 and looking forward to meeting all his good friends there. . . . **Milton G. Hulme, Jr.** has voluntarily stepped down as chairman of Thorofare Markets, Inc., located in Youngstown, Ohio, to pursue other business and civic responsibilities, but remains a director. . . . **Karl Eklund** of the Myricks section of Berkley, Mass., was recently named energy management coordinator at the Southeastern Regional Planning and Economic Development District in Marion, Mass., Karl will assist district firms, communities and groups to overcome evergy problems in a way that will help regional economic development. He will seek to develop alternative energy resources as well as energy conservation measures. Before joining the staff at SRPEDD, he served as an energy consultant to the Town of Lakeville, the City of Taunton, and the Taunton Consumer Protection Program. He was also a consultant to aerospace firms for instrumentation and automatic control devices.

On Friday, December 5, Howard W. Johnson, chairman of the M.I.T Corporation, presided at a luncheon at the Faculty Club at which 41 M.I.T alumni, who are top corporate executives, were presented with inscribed Paul Revere bowls to recognize distinguished corporate leadership. The lun-

cheon speaker was **Kenneth H. Olsen**, president of Digital Corp. of Maynard, Mass., a recipient of a Corporate Leadership Award in 1976. These awards honor individuals whose responsibilities in private industry mark them as exceptional contributors to the continued strength and well-being of private enterprise in this nation. Three-quarters of M.I.T.'s alumni take positions in industry and business. Among these recipients were **Sidney Topol**, chairman of the board and president of Scientific-Atlanta, Inc., located in Atlanta, Ga.; and **William D. Walther**, president and chief operating officer of Dayton-Walther Corp., located in Dayton, Ohio.—**John T. McKenna**, Secretary, 1 Emerson Place, Apt. 11H, Boston, MA 02114

51 30th Reunion

Our 30th Reunion is fast approaching! Plan to be at the *big* bash in Cambridge, Boston, and Marblehead on Thursday, June 4, through Sunday, June 7. You already have received a list of those classmates planning to attend, but there will be more there, too. **Gene Lubarsky** has been trying to convince **Evan Evans** to make this big reunion. And Evan will be there when he convinces his better half that they can visit Canada later this year. **Bill Maini** is doing a great job as Reunion Chairman, and it looks like '51 will lead the Institute again with the largest reunion ever. Maggie and **Jim Russell** will steam all those clams and lobsters for us at the Corinthian Yacht Club. Don't miss it!

We received a wonderful letter from **Hal Siegel** who is alive and well and living in Greenbelt, Md. Hal writes, "I deserted the ranks of metallurgists and opted for a career in law, with heavy emphasis on technical disputes between the customer and the government over specification parameters. My general practice of law is based in Greenbelt, Md. However, I also serve as vice-president and general counsel of Radiation Systems, Inc., (RSI), an antenna manufacturer of large "dishes," located in Sterling, Va., near Dulles Airport. I also serve as secretary and member of the board of directors of RSI's subsidiary, Universal Antennas, Inc., located in Dallas, Tex.

"On the domestic front, all but three of eight children have moved out. Of the older set of twins, Sandra has married and works in the computer field with ITT; her sister Brandy is attending graduate school at Adelphi University on Long Island, N.Y. Of the younger set of twins, Marc is a part-time town policeman and is a junior at the University of Maryland; his sister Pamela graduated from Frostburg State College in June and was commissioned under the Army ROTC program with honors.

"My next younger son, Kevin, has just started at the University of Maryland, lives with his brother, Marc, and makes pizzas for a living. Trevor graduates from high school next June; his college plans, if any, are unknown. He shows great promise in things theatrical. Sean and Shelly are still in grade school.

"And, oh yes, my wife Valerie went back to school full time at night at University College on the University College on the University of Maryland campus. She'll be ready to enter law school next September." We look forward to seeing Hal and Valerie at our reunion in June.

John Stewart has been named president of Holga Metal Products Corp., a division of Hon Industries. John's business is based in Van Nuys, Calif., where Holga is a leading manufacturer of metal office furniture. Prior to joining Holga, John served as director of manufacturing operations for Anderson Hickey Co. in Texas, and plant manager for InterRoyal Corp. in Connecticut. A former director of the Chamber of Commerce, a member of the American Management Association and various mental rehabilitation and youth organizations, John and his wife reside currently in Saugus, Calif. . . . Congratulations again to **Mert Flemings** who was elected last year to membership in the American Academy of Arts and Sciences, in addition to his responsibilities as Ford Professor of Engineering, and director of the newly organized Materials Processing Center in the M.I.T. School of Engineering. Mert's colleague from Course III, **Dave Ragone**, president of Case Western Reserve University, was elected a director of Cleveland-Cliffs Iron Co. and National City Corp., both of Cleveland, Ohio.

Richard Warfield notes that his business activities required a move from Houston to Midland, Tex., where he opened consulting offices for oil and gas exploration. When you're out in west Texas, give Richard a call at (915) 699-7339. . . . **Art Wasserman** continues his good work as managing director of Allis-Chalmers Great Britain, Ltd. Art writes that 1980 witnessed significant growth for his company through merger of a complementary subsidiary with facilities in Southhampton, England, and acquisition of a large manufacturing plant in Glasgow, Scotland, permitting a higher degree of in-house production of their mineral processing equipment. Despite the recession in Great Britain, Art is bullish on the British market in the longer haul and on the opportunities for exports to Africa and the Middle East.

If **Walt Brill** can get off the golf tour in Delaware and Maryland for only one week, we hope he will take a June vacation with his charming wife Rose and make it to the 30th Reunion. We look forward to seeing all of you at Tech, June 4-7, 1981. Mark your calendar now. Our Course XIX classmates forecast a warm and sunny June in Cambridge. Be there and enjoy!—**Paul Grady**, Assistant Secretary, 16 Brook Lane, Greens Farms, CT 06880

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Gen Rad, Inc., Concord, Mass., has announced the appointment of **Harold T. McAleer** to the position of senior vice-president fo product development. Hal has been transferred from his position as general manager at Gen Rad, Santa Clara, Calif., to corporate headquarters in Waltham, Mass. . . . **Theodore M. Parsons** is now an account executive for Merrill Lynch in Miami. . . . **Stanley I . Buchin** has been named senior vice-president of Temple, Barker, and Sloane Inc. of Lexington, Mass.

Suisman and Blumenthal, Inc., processors of scrap, have named **Frank Spinelli** of Meridan, Conn., as vice-president of purchasing. Frank came to S & B from a major stack brokerage firm in 1974, and formerly worked at Pratt and Whitney Aircraft. Prior to his appointment as vice-president, Frank served in purchasing as an account executive, as manager of aluminum sales, and most recently, as manager of titanium sales. He is an active member of the American Society of Metals. . . . **James S. Stolley** has been named senior vice-president of Hammermill Paper Co., Erie, Pa. He will assume responsibility for Hammermill's converting operations while retaining responsibility for Strathmore Paper Co. and Hammermill's timberlands and forest products operations.

Lloyd A. Currie, research chemist at the National Measurement Laboratory, the National Bureau of Standards, has been awarded the Silver Medal Award—the second highest honor award conferred upon an employee by the Department of Commerce. It is bestowed for "meritorious contributions of unusual value to the Department." Lloyd was honored at the 32nd Annual Honor Awards Ceremony held at the Department fo Commerce, November 6, 1980. Dr. Currie's work in improving radiocarbon measurement techniques for environmental samples and his contributions to the difficult field of multicomponent source identification in environmental studies marks an outstanding achievement. The mini-proportional counters that he developed are capable of making accurate carbon-14 measurements on samples as small as a few milligrams. Dr. Currie made the first accelerator-derived measurements of carbon-14 on samples as small as 20 micrograms. This research has opened the field of radio-carbon dating to sample materials of limited mass such as atmospheric particulates, ice cores, deep ocean sediments, and small subsamples from valuable specimens in museum archives.

Nick Haritatos writes that he is working on many interesting process design projects, including minerals and biochemical projects in addition to the usual oil and petroleum work. "One project involves making alcohol in Kentucky. Unfortunately, the alcohol will be denatured with gasoline, so it won't be fit to drink." His extracurricular activities include teaching Sunday school and going to music recitals to hear his children play. . . . **Don Tarinelli**, president of the Stratton Corp., which operates the commercial ski area with the same name, has recently been written up in the *New York Times* magazine. Don was one of the founders of the Stratton Mountain School, an excellent secondary school already beginning to produce world class skiers. Many of the graduates of the Stratton school have become members of the U.S. Olympic ski team, including Don's daughter Deborah. Deborah, after graduating from Stratton went on to Dartmouth where she raced on the woman's ski team and was chosen Woman Athlete of the Year. She is now doing graduate work in urban studies at Harvard. His son, also a graduate of Stratton, became a college ski racer and is now a ski coach at Williams College with ambitions to be an architect.—**Arthur S. Turner**, Secretary, 175 Lowell St., Carlisle, MA 01741; **Richard F. Lacey**, Assistant Secretary, 2340 Cowper St. Palo Alto, CA 94301

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Lou Mahoney, where are you now that I need you? Lou has been responsible for getting out the class notes for the past year and a half and has done a super job. I didn't realize how hard a job it was until I had to sit down to write this. Lou was promoted to vice-president of Refining Operations for Revere Sugar Corp. and has now moved to New Jersey. We wish Lou the best of luck in his new position, but we sure do miss him.

Two members of the Class of '54 were among the 41 alumni who were honored with Corporate Leadership Awards by M.I.T. at the Corporation Luncheon in December. They are: **Robert Brown**, president and chief operating officer, Belding Heminway Co., New York City and **Kevin Woelflein**, president, UBAF Arab American Bank, New York City. We're glad to see that the Class of '54 was so well represented. It's also nice to know that a chemical engineer can become a bank president.

Another chemical engineer, **Edward Hair**, was named a fellow of the American Institute of Chemical Engineers. Ed, who works for Proctor and Gamble, lives in Cincinnati and is the holder of 12 U.S. and two foreign patents. These are in the area of food products such as coffee, prepared mixes, shortening and oils, and peanut butter. Maybe we can arrange for a loan from Kevin to buy some peanut butter from Ed?

Martin Lubell was elected the first president of the applied Superconductivity conference, Inc. ASC is a new national organization formed to coordinate biennial meetings on the subject of superconductivity. Martin is head of the magnetics and superconductivity section of the Oak Ridge National Laboratory's Fusion Energy Division. . . . Martin isn't even an engineer, but he certianly is a superconductor!

If I don't get fired after writing this, I'll need info for future class notes, so please send anything of interest to me, **Mickey Sama**, or to the other assistant class secretaries.—**William Combs**, 120 West Newton St., Boston, MA 02118; **John Kiley**, 7 Kensington Rd., Woburn, MA 08101; **Louis Mahoney**, 52 Symor Dr., Convent Station, NJ 07961; **Dominick A. Sama**, 28 Chestnut Hill Rd., Groton, MA 01450

55

Hi! We have a number of brief items this month, the by-product of year-end pledges. We are thinking of establishing some form of charitable foundation to solicit monthly contributions, primarily to elicit a continuing flow of news items and, incidentally, for who knows how many other worthy charitable purposes. Ah well, on to the news . . .

In the world of acronyms, we hear from **Oscar H. Hobbes** from Lagos, Nigeria that he retired from SNET in April 1979, joined TCOM in Columbia, Md., in August 1979, and has been working for two years in Lagos. Oscar, you've left your reporter in total confusion—how about a further contribution to spell out your status?

Ronald A. Howard recently joined Resource Planning Associates (RPA) as a consulting principal specializing in decision analysis for corporate and governmental clients in natural resources, energy, and related fields. Ron is a professor of engineering-economic systems at Stanford University and of management science at the Graduate School of Business at Stanford. He received a B.S. in economics, and a B.S., M.S., E.E., and Sc.D. (1958) in electrical engineering, all from the Institute. He has published widely on decision analysis and computer systems, including the two-volume *Dynamic Programming and Markov Processes, Dynamic Probabilistic Systems*. In addition, he is an editor of *Management Science*.

Franceline Cullen Leary (Course V) of Schenectady, N.Y., wrote to the *Review* a few months ago to report three generations of Tech graduates: her father James A. Cullen, '28, she and her husband Eugene A. Leary, '54, and her son James J. Leary, '80. Congratulations to the latest Tech grad in the clan.

We also have a brief note from **Jukka Lehtinen** who reports he has been working for Oy Tampella Ab of Tampere, Finland since 1972.

On the college front, **Norman Poulin** writes us that his daughter Linda is graduating this year from Seton Hall University, N.J., having majored in business administration. Norm is the senior vice-president and director of manufacturing of Belding Corticelli Co.

In a like vein, **Dell Lanier Venarde** reports that her oldest child Bruce is now at Swarthmore College. Dell vecationed in the Italian Alps and points south with her family this fall and then completed her children's novel. Perhaps we can print excerpts if we run out of material for this column. As a brief aside to Dell, your New York correspondent's eldest, Lisa, is a sophomore at Swarthmore. Perhaps we can get Bruce and Lisa to meet one day while at that august institution.

Must end on a sad note—our condolences to the family of **Richard E. Sipfle** (Course VI) who perished in the fire last November at the MGM-Grand Hotel in Las Vegas.—Co-secretaries: **Marc S. Gross**, Winding Road Farm, Ardsley, NY 10502; **Allan C. Schell**, 19 Wedgemere Ave., Winchester, MA 01890

56 25th Reunion

By now you should be nearly registered for the Great Come Back for '56, the last chance for your M.I.T. 25th. We hope, too, that you've responded appropriately to providing some return on the investment which earlier generations of alumni put into our education. Certainly most of us have done well by our affiliation with M.I.T. and didn't pay for it all while we were there. And we still benefit from the continued progress and excellence of the Institute. So, let's dig deeper and keep M.I.T. worthy of our pride.

You've probably had plenty of reminders about the events starting June 4, but please give me or any of the committee a call with any questions. No doubt the Pops tickets will be sold out, but we'll try to help you with the other events.

We heard that **George Garfinkle** will be entering Suffolk Law School this fall, to add still more qualifications to his several careers. George is a partner in the Boston architectural firm of Gantaume and McMullen and is a CLU active as broker of corporate group pension and life insurance programs. . . . **Irwin Dorros** is assistant vice-president for network planning of AT & T in Basking Ridge, N.J. He's been with Bell Labs and AT & T since graduation but has also completed his M.S. in electrical engineering at M.I.T. and a Ph.D. in electrical engineering at Columbia. Irwin recently published an article on stored program control for telecommunications networks.

The M.I.T. Corporation has conferred Corporate Leadership Awards on several of our classmates: **Joseph Gaziano**, CEO of Tyco Laboratories, Exeter, N.H.; **Philip Spertus**, chairman of Intercraft Industries of Chicago; and **Jerome Vielehr**, president of Schlitz Brewing Co. of Milwaukee. That's quite impressive, and we hope to congratulate these men in person at the Reunion.—Co-secretaries: **Warren G. Briggs**, 33 Bancroft Rd., Wellesley Hills, MA 02181, (617) 235-7436; **Bruce Bredehoft**, 7100 Lanham Ln., Edina, MN 55435

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Joseph Maybank, a principal of Architectural Resources Cambridge, Inc. reports that his firm received award of Excellence in Architecture from the New England Regional Council for the American Institute of Architects. This award was for the design of the John F. Kennedy School of Government at Harvard University.

In the world of academia, Babson College announced the appointment of **Mel Copen** as vice-president for academic affairs and dean, School of Management, effective January 1981. . . . **Dick Hughes** writes that he is "continuing to teach Soviet government and Soviet foreign policy, but I have retrained to teach fluid mechanics at the undergraduate level here at California State University in Sacramento. We now have two grandchildren." . . . We also received a note from **Joyce Rubissow Carlyle** telling us that in March 1979 she was appointed senior lecturer in pediatrics at the University of Birmingham Medical School in the United Kingdom. She notes, "My name has also changed to **M. J. Carlyle**, M.D. Hello to CLASS OF '58, Course XXI." . . . **Martin Victor** is still at Homestead AFB where he is chief of hospital services. His daughter Beth graduated last year from Mount Holyoke and is now attending Duke Law School while his son Philip graduated from Cal State at Fresno with a degree in industrial technology. . . . **Merle Persky** has joined the engineering research staff of the Applied Sciences Division of Aerodyne Research, Inc. as a senior research engineer. His responsibilities will be primarily in the area of design and analysis of electro-optical field measurement programs. Previously, he was a program manager for Block Engineering, Inc. in Cambridge, Mass.

Although we reported earlier on **Roy Scarpato**'s move to Honeywell's MicroSwitch Division, we received a note from him filling in some additional details. "It was quite an experience," he said, "to move our household (and four children, dog, and cat) to Freeport here in the heart of middle America. Happily, our transition is aided by the fact that my new responsibilities will require periodic visits back to our Marlborough, Mass., facility." . . . **Bill Hauke** would like to hear form any Phi Kappa Sigma class members, so give him a call. He is still in the construction business and also engaged in commercial and residential management and wholesale supply. Carol and Bill now have four children, the oldest of which will enter college next year. This time he is working on the design and development of a very high-speed, composite contruction, two-place aircraft. His letter says, "I plan to build the plane at home and fulfill a near-lifelong dream to use part of what I learned at the 'old engineer factory.' It will be powered by a pair of motorcycle engines. Wish me luck!" . . . So, with best wishes for a soaring flight, we say farewell to this issue.—**Michael E. Brose**, Secretary, 59 Rutland Square, Boston, MA 02118

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I received a letter from **Ron Troutman** of IBM General Technology Division in Essex Junction, Vt. He wrote concerning the contest I held last year to identify VLSI and other related acronyms. Ron was the only person to respond and supplied all the answers including VLSI and Very Large Scale Integration, meaning more than 100,000 transistors per chip. He presented a seminar on the subject at M.I.T. last November. . . . **Rober J. Elliott** is a partner in the Management Information Consulting Division of Arthur Andersen and Co. He and his family recently spent four years in Japan running their data processing systems practice and are now back in their San Francisco Victorian abode. . . . **Phil Schmidt** is in his third year as associate dean of the Graduate School at the University of Texas in Austin. He will be taking sabbatical leave in June to work on an industrial energy conservation research project at the Electric Power Research Institute in Palo Alto, Calif.—**John E. Prussing**, Secretary, 2106 Grange Dr., Urbana, IL 61801

63

Keep on spoiling me— I love it! Another month with a class hero—or, to be more specific, a class heroine. I received a newsy letter from Georgie and **Jim Hallock**. The occasion was Jim's 40th birthday. Georgie gave him a surprise birthday party which featured a belly dancer delivering a belly-gram. The Hallocks recommend a happy birthday message written on a lithe tummy as a very pleasant way to ease into one's 40th year. Also sending Jim birthday greetings were **John Gallagher**, John Meriwether '64, George Krebs '62, and Ralph Zimmerman '64. The Hallocks also had a visit after New Year's from Andrea and **Don Knutson** and their son Allen. Allen received an Apple Computer as a Christmas gift (he is 11), but he is competing for machine time with his parents. Georgie and Him had a note from **Allen Meyer**, wondering about the fate of science under the new administration, and a letter from **Roger Pyle**, bringing them up to date on his family's doings for the last year. Roger is at the University of Chicago, and his work involves space projects, such as the Pioneer and Voyager flights to Jupiter and Saturn. Wife Tiza left the University of Chicago last year and is now with the Northern Trust Bank. She is continuing her studies toward an M.B.A. and is taking courses along with her work at Northern Trust. The Pyle's children, Kathy and Bob, are in seventh grade at the University of Chicago Lab Schools.

Glen Books informs us that in addition to practicing patent law in Boston, he is coaching debate at Phillips Academy in Andover. He is enjoying his work with the talented youngsters on his teams. . . . **Allen Clark** writes that he and his wife Jeanne and children—Sherry, 16, Merilee, 14, and Kenneth, 12—are settling into their new home in Winter Park, Fla. (about 20 miles from Disney World.) Al has recently been transferred (promoted) from a corporate R & D to manage citrus R & D for the Foods Division of the Coca-Cola Co. The Clarks are looking forward to canoeing and camping in Florida. . . . **Mark Epstein** reports that he and Ellen Williams, '67, are living in Kensington, Md., with their 2-year-old son Jeffrey. Mark has been working for the Defense Department for about five years, and he enjoys both the work and the Washington area. Recently he was appointed deputy for communications and target acquisition within the office of the Secretary of the Army, with management responsibility for all Army electronics programs.

Several news releases bring information about our classmates. The Higher Education Division of the Addison-Wesley Publishing Co. announces the publication of *Problem Solving and Structured Programming in Pascal* by **Elliot Koffman**. Elliot is at Temple University. . . . **Henry Reeder**, of Architectural Resources Cambridge, Inc. has received an award of Excellence in Architecture from the New England Regional Council of the American Institute of Architects for his work on the design of the Kennedy School of Government at Harvard. . . . And **John Castle** was honored by M.I.T. along with 40 other alumni who are leaders in business, finance, or industry. John is chief operating officer of Donaldson, Lufkin, and Jenrette, a leading investment and securities firm based in New York City.

Well folks, that's the news for now. Keep those cards and letters pouring in. (Ha, ha.) —**Mike Bertin**, Secretary, 18022 Gillman St., Irvine, CA 92715

64

Dear classmates, you missed us last month—that was our fault. Even if we had made the time to write the column, it would have been void of news—that was your fault. This month we have some class notes via your wonderful "contributions" envelopes. Keep them coming! But how about a personal letter or two as well?

Our first piece of news, regretably, is to report the

death of **Henry K. Dewey, Jr.** on October 13, 1980, in Geneva, Switzerland. We have no further information at this time. . . . **William Euerle** is still living in Foxboro, Mass., with wife Anne and two sons, Billy (8) and Danny (4). Bill is a manager of Porne System Computer application for the Foxboro Co. He occasionally sees **Ernie Cohen**. . . . **Leslie (Bud) Boring** is now assigned to Citibank in Paris, France, as head of the Construction and Engineering Marketing Unit for France. Bud writes, "This new assignment brings me into a much more sophisticated banking environment after six years in the Middle East." The entire Boring family is enjoying the change in lifestyle, especially Bud's wife Annie who happens to be French!

Ron Gilman was elected a fellow of the American College of Probate Counsel and was also elected to a two-year term (1981-82) on the board of directors of the Memphis and Shelby County Bar Association. . . . **E. M. Cohen** is project engineer in systems operations at the Foxboro Co. he also sees **William Euerle**. . . . **Oliver C. Boileau, Jr.** received the Corporate Leadership Award from M.I.T. Oliver is president, General Dynamics Corp., St. Louis, Mo. . . . **Michael Auerbach** spent two and one-half weeks in Germany last march running a desalination trial of Pfizer's new antiscalant polymer; the trial was successful. . . . **John Hanson** was named president of Solar Turbines International. he will be nominated to become a corporate vice-president of International Harvester. . . . **Robert Hobbs**, senior theoretical physicist at the United Technologies Research Center in East Hartford, Conn., is working on projects ranging from the structure of coal to mechanisms of energy transfer in molecules. Away from the office, Robert runs intercollegiate sailing regattas, serving as executive director of the national governing body of college sailing, ICYRA. . . . **David Hoover** was named assistant dean of the Barney School of Business and Public Administration at the University of Hartford. He joins their staff with a background in planning and budgeting. He will work on developing grant proposals and budgetary and other administrative matters for the Barney School.

Now some news of classmates we have seen and spoken to! . . . We met **Po-Chiu Mar** at a preseventh grade indoctrination for parents. The Mars and the Schlossers are both parents of prospective junior high students. How time flies! . . . Ellen and **Gary Walpert** visited the Washington area recently for business and pleasure. They had Tara, Ellen, and (recent arrival) Kirsten with them. We had the pleasure of two visits during their stay, both at Marilyn and Don Goldman's, '65, house. One was "adults only" and the other a full family affair, both lovely. The Goldmans are terrific hosts.

That's it for this month. Please keep the news coming. Ciao!—**Steve Schlosser**, Secretary, 11129 Deborah Dr., Potomac, MD 20854

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Well, last month was feast and this is back to famine. We have a letter from **Martin Goldsmith** and a few notes and clippings.

Martin is a physician living in Needham, Mass., and works as clinical associate professor of radiology at Tufts University and as a staff radiologist at the Veterans' Administration Hospital in Jamaica Plain. he also has a private radiology practice in Wellesley. His work has led him into the use of computerized body tomography for evaluating bone and musculoskeletal disorders. Martin reports that his wife Karen has returned to college for an associate's degree in legal secretarial work. His son Michael, 10, is an avid baseball and basketball player and sports fan, while Craig, 6, is into downhill skiing. Martin's hobbies are golf, skiing, and ice skating.

After 15 years with Hughes Aircraft in Tucson, **Chris Miller** has moved back East as a staff technical advisor for HRB-Singer in State College, Pa. Chris says he has enjoyed watching the Nittany Lions play football. . . . **Steve Deutsch** has become a partner in the law firm of Foley, Hoag, and Eliot of Boston. . . . **Dick Bator** is now financial systems technical manager of Interactive Systems, Inc. of Burlington, Mass. . . . **Dick Nathan** has been named manager of the Nuclear Technology and Physical Sciences Department at Battelle Columbus Laboratories.

Finally, a little more personal news from your humble and obedient correspondent. (I figure if you won't write me with news, I'll make it myself.) After almost 12 years with the MITRE Corp., I've decided to move on to the world of profit-making industry. By the time you read this, I should be ensconced as an engineering manager in the Corporate Research Group at Digital Equipment Corp. I'll be responsible for their work in computer security (which I managed for some years at MITRE) and hope to gain some experience along the path from idea to profit-making product. I'll be working at Digital's old woolen mill in Maynard, Mass., initially, so home will remain in Wellesley.—**Steve Lipner**, Secretary, 6 Midland Rd., Wellesley, MA 02181

66 15th Reunion

Well, I actually received two direct communications from class members this month. That's a start! **Howard** and **Margaret Shork Chatterton** write that Howard joined the faculty at the naval Academy in January. Expect that they and their three girls will remain in Bowie, Md., where they have spent most of the last 15 years. They are more settled than most of us. Perhaps we should have awards at the reunion—lived longest in one place, most moves, most job changes, most kids. . . . I also received a phone call from **Tom Hutzelman** who lives a mere 90 miles west of us in Erie, Pa. Tom is now the president of his family-owned business, Flex-Y-Plan Industries, Inc., a maker of office partitions. He and his wife Barbara have two boys—Jeff, 8 and Brian, 4. When I talked to him he had just returned from the inaugural festivities in Washington.

The Student Chapter of the American Society of Civil Engineers gave its Outstanding Teacher Award to **Wilson Tang**. He is professor of civil engineering at the University of Illinois at Champaign/Urbana specializing in risk and reliability analysis. . . . **Alan Dinner** writes that he married Anne Resnic in January. After a honeymoon in the Caribbean they both returned to work at Eli Lilly and Co., in Indianapolis. . . . Dr. **Everest A. Whited III** is now in family practice in Dalton, Ga. Also in Georgia, **Wayne Baxter** has a thriving computer business. . . . **Frederick Webb** is in charge of software development and maintenance of a software package, RS/1, for Bolt, Beranek, and Newman, Inc., in Bedford, Mass. He and his wife have three children, all boys, "all showing evidence of being future M.I.T. material."

William has flown off to pick up the newest addition to the family, a flight simulator for **Klepser**'s Flying Service. This will allow us to fly right here in the house, which is about the only place you can safely fly a small plane in our snowy, foggy hills from November to March. Maybe now we shall all learn to fly . . . at least you can crash a simulator without hurting anything.

The reunion is fast approaching. Bring your children—they have so many activities for them it's just like going to camp. I hope you all voted for the clambake. I can just hear that surf, feel the warm sand, and smell those juicy clams aroasting. See you there.—**Eleanore Gieron Klepser**, Secretary, 317 Broad St., Port Allegany, PA 16743

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Robert Landley has been living on the small island of Kwajalein for almost four years. Although an island only three miles by one-half mile has its disadvantages, he is able to vacation in Hawaii. . . . **Alan Hausrath** announces the birth of his second daughter, Katherine Mérida McMartin Hausrath, on January 27, 1980. She is named after the city in Venezuela where Anne and Alan spent 1979-80. . . . **George Nybakken** is working at the Research Center of Uniroyal, Inc. in Middlebury, Conn. . . . **Alex Wilson** received an award for the best paper of 1979 in the American Society for Mechanical Engineers' *Journal of Engineering Materials and Technology*. The title of the paper is "The Influence of Inclusions of the Toughness and Fatigue Properties of A516-70 Steel." . . . The NASA Certificate of Commendation has been awarded to **John Jamieson**. As a senior software engineer for the John F. Kennedy Space Center's fluid services division, John is responsible for the loading of liquid oxygen and liquid hydrogen onto the Space Shuttle vehicle before launch. A citation accompanying the award praised Jamieson for "outstanding technical leadership in the development and verification of the main propulsion system propellent loading software for the shuttle transportation system." John lives in Merritt Island, Fla., with his wife Joan and their children John, Jacqueline, Jeanette, and Diana.

Sheri and **Jeff Schoenwald** are the proud parents of Joshua Anson, their first child, born on October 10, 1980. Jeff points out that Joshua will celebrate his 30th birthday on 10/10/10. Jeff is working at Rockwell International in Thousand Oaks, Calif., where he is doing research in the field of surface acoustic waves. Sheri received her master's in psychology last June and is working part time. . . . Jane and **Ron Gomes-Casseres** were married shortly after graduate school and now have three children ranging in age from 9 to 3. Having managed to never work in an engineering position, Ron is currently assistant to the managing directors of the Madure and Curiel's Bank, the largest banking institution in the Netherland Antilles.—**Jim Swanson**, Secretary, 878 Hoffman Terrace, Los Altos, CA 94022

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Not having learned to leave well enough alone, Sina and **Tom Najarian** have again volunteered to host a class reunion at their summer home in Hull, scheduled for the first or second Saturday in August. Watch this space next issue or contact Sina at (617) 484-0744 or myself at (617) 868-9788 to be sure of getting further details of our 12th Reunion.

I've been keeping very busy. My trip to Czechoslovakia went very well—a lot of work but, with most of my film now processed, it looks well worth the trip. Now if I can only get the book out by Christmas. Last week the Michael Moorcock book was delivered to the printer, which now leaves only *Modesty Blaise* behind schedule.

Ka-Hung Fogg has left the States for Hong Kong, where for the last year he has been working as a technical support at Broadway Management Service Ltd. . . . Not so far away in are Jodi and **Hank Levine** who, having been Yankees all their lives, have settled in Tulsa, Okla., where Hank has established his own pediatric practice and Jodi is assistant director of the Eastern Oklahoma Prenatal Center. They both hold voluntary faculty appointments at the medical school and enjoy the town very much. They've continued growing orchids, which they picked up while in Miami, and have raised several awarded clones.

Still in Miami are Linda and **Jeff Weissman**. Jeff has joined the new law firm of Sparker, Shevin, Rosen, Shapo, and Heilbronner, where he is continuing to practice civil litigation. Their daughters Karen (5) and Erica (2) are a great joy. . . . After working ten years for the UC Office of the President, **Greg Kast** has gone to work for Bechtel Power Corp. as a system specialist concentrating on administrative and project control applications. . . . **Michael P. Timko** has been promoted to manager of Computer Aided Design at Analog Devices' Semiconductor Divison. Michael has been with ADS for the last ten years and lives in Burlington, Mass., with his wife Judy.

That's it for this month, Keep in touch for further news on our 12th Reunion.—**Robert K. Wiener**, Secretary, Box 27, M.I.T. Branch, Cambridge, MA 02139

71 10th Reunion

Del Knarr visited me in Brenham recently. You all remember Del as the suave and sophisticated Delt whose brilliance challenged all of our profs. He is with Martin and Stern, Inc., 1112 Ocean Ave., Manhatten Beach, CA 90266, as a project manager/operations analyst. He asked for some help in locating the missing pledge from the Delt pledge class.

The pledges he remembers are: **Tim Walsh**, **Ed Buchak**, John Dieckmann, Bob Armstrong, **Frank Taylor**, Bob Kassouf, Cliff Ananian, **Hal Moorman**, **Chris Brewster**, **Jim Shields**, Del Knarr, Dan Blodgett, Brett Cantrell, Joe Krajc, Mike Oakes . . . who is the missing pledge? . . . **George M. Alvares-Correa** has been named a director of Mortgage Investors of Washington. . . . **Richard Hartmann** is acting chief resident in OB/GYN at Jewish Hospital in St. Louis. He and Susan are expecting a child in March who will join his 2-year-old. He welcomes all friends to visit him in St. Louis.

Mehdi Jazayeri . . . has left the UNC to become a senior scientist with TRW Vidar in Mountain View Calif. The company builds digital telephone switches. He and Mary have one son, Darius, and are expecting a daughter in May. . . . **H. Dubose Montgomery** wrote a nice letter. He finished his master's in electrical engineering at the 'Tute and graduated from the Harvard Business School, during which he married Nancy Timmerman, a Wellesley graduate. Dubose started management consulting in San Francisco and was a co-founder of California Northwest Fund, Inc., a $25 million venture capital investment firm in Menlo Park, Calif. Since then he has invested in 20 emerging growth companies on the West Coast. Dubose has been president of the M.I.T. Club of Northern California as well as a director. He has received the Harold E. Lobdell Class of 1917 Distinguished Service Award for his fund raising activities, was recently appointed chairman of the M.I.T, Alumni Activities Board and was elected to the M.I.T. National Selection Committee. His wife, Nancy, went to the Stanford Business School and attained an M.B.A. and C.P.A. and is currently controller for Econics Corp., a high technology company in Sunnyvale, Calif. Dubose and Nancy have no children, and, with all of their—activities, it is obvious why. . . . I was recently elected president of the Washington County Chamber of Commerce and am a member of the City Development Board.—**Hal Moorman**, P.O. Box 1808, Brenham, TX 77833

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Hay thar. Such an embarrassing dearth of news has crossed my desk that I feel obliged to remind you of some. World War II ("WWII," "the Big One") is over. Millard Fillmore is dead. So is James Garfield, 100 years ago September 19.

More recently, **Bill Dannelly** and wife Pam (sister of Bob Kispert, '68, and daughter of the late Malcolm Kispert, '44) gave birth to Lauren Elizabeth ('03) on November 17, 1980, their first.

O.C. (other correspondent) **Matt Goetz** graduated from Tufts Med School in 1977 and completed his internal residency in Minneapolis. He's now an infectious diseases fellow (?) at the University of Wisconsin and is back in the lab doing research on the activation of oxygen metabolism in neutrophils.

Tony Scandora is unchanged. **Dorian Punj** is hereby identified as the name TR left out of the last issue at the top of my column. (They always do that to me!) And by the time you read this, my kid will be born. You're probably tired of hearing already! Write.—**Robert M. O. Sutton**, Secretary, 819 Buckingham Ct., Warrenton, VA 22186

74

Once again, man and nature conspire to produce an apocalyptic event: a class get-together! For those of you who live beyond the outer reaches of civilization (somewhere past New Jersey or Philadelphia), this will be your only warning. On Sunday, June 7, 1981, the alumni pool will be available to the Class of 1974 from 11 a.m. to 4 p.m. for an enjoyable set of activities. One of these activities will be eating. Arrangements have not been finalized as we go to press, but I have some idea what you might expect. Luncheon will be provided for the low, low price of around $6.00 per person with a marginal charge for children under 12 and no charge for 6 and under. The fare will probably consist of the chicken and hot dogs variety and will include beverages of the appropriate chemical compositions. For more information, please contact any class officer.

Naomi Markovitz writes from Israel that she is heavily involved in the education system at Kibbutz Shluchot in the Beit Shaan Valley. Her letter describes in some detail her teaching role as well as her administrative duties with regard to scheduling and class structure. Despite the long hours she spends with her career, she still has time to drop a line to the Notes. You should all follow her example. Thanks, Naomi.

John Looper has left Princeton's graduate program in romance languages and is now a first-year student at Rush Medical College in Chicago where he intends to specialize in neuro-linguistics. . . . **Richard L. Trachtman** has been named governmental affairs representative for the American Society of Internal Medicine (ASIM), where he is a full-time registered lobbyist handling the society's day-to-day liaison with Congress and federal agencies. . . . **David L. Akin** is still planning on getting his Sc.D. in June but has acknowledged that the year has slipped from '79 to '80 to '81. He is still working in the Space Systems Lab and vows to have his thesis presentation before the first Space Shuttle launch. . . . **Roy Harrington** recently finished writing an operating system for Cromemco, the microcomputer manufacturer. He has also moved to a new house recently.

John Stiehler is now working for Neiman Marcus as department manager for men's furnishings. John remarks that after 16 months in Dallas, he and his wife are starting to get adjusted to it but are still suffering withdrawal pains due to a lack of culture in the area. . . . **Steven A. Glazer** is working in energy law at the Washington, D.C., law firm of Morgan, Lewis, and Bockius. On November 2, 1980, he married Marcia Horwitz who is an architect with the firm of Skidmore, Owings, and Merrill in Washington. . . . **Robert Colopy** has started a new business in Portola Valley, Calif. Colopy and Associates is a business consulting firm specializing in competitive analysis and new product strategy. Good luck to you, Richard. . . . **Sheldon Lowenthal** and his wife have had a second daughter born on April 20 of last year. Sheldon is still at Lexidata Corp. in Burlington, Mass., developing new display drivers.

Remember June 7. If your address isn't current with the alumni data base, you won't receive the next mailing which contains two free tickets to the island of our choice.—Co-secretaries: **Jim Gokhale**, 12 Pond Lane, Arlington, MA 02174; **Lionel Goulet**, 34 Tremlett St., Dorchester, MA 02124

75

Summertime and the living is easy. However, because light travels at a finite speed (and because it bends in the neighborhood of the news in this column is from last winter.

On December 13, 1980, **Mike Bercher** received an M.B.A. in computer systems from the University of Toledo. . . . **Jeffrey Star** has *finally* (emphasis his) finished his Ph.D. in oceanography at Scripps. He plans to stay there for two years as a research biologist studying marine bioluminescence. . . . "First half of a two-year experiment in Texas living, a success," **R. W. Mann, Jr.** proudly reports. He is "managing the resource planning function at American Airlines, attempting to position us to best exploit deregulation. Mixed results to date. Much pre-deregulation momentum still need to be dissipated." I look forward to finding out the results of the complete experiment and to seeing how deregulation works out.

Michael Jung has joined the Dallas law firm of Strasburger and Price, specializing in trial and appellate litigation. He was in Boston with his wife, Gretchen Megowen, '76, to attend the wedding of Bob Van der Kloot, '76, to Paulette Humphrey, a student at the Fletcher School. Among those at the wedding: **Brian Rehrig**, '75, Bob Resnick, '76, Nick Nussbaum, '76, John Avery, '76, Rick Miller, and Jack Peers, '72. . . . **Harlan R. (Nick) Davis** says he has changed jobs four times in ten months: Braniff Airlines, a paper company, (pilot for) a glider operation, and finally a hydraulic valve manufacturer, where he holds his present job of sales engineer. "There is life after Course XV!" he says. Nick adds that eight out of 13 members of our class showed up at a PBE fraternity reunion in September, close to a record. . . . **Diane McKnight**, as previously reported in this column, is married to Larry Esposito, '73, and works for the U.S. Geological Survey. Diane wrote in of her disappointment over our recent choice for president. Her work involves studying the water quality of Spirit Lake and other lakes in the blast zone of Mt. St. Helens. I enjoyed reading Diane's letter, which shows genuine interest and concern about M.I.T. affairs, but I can't reproduce all of it here.

And, from Mr. Reagan's home state of California, **Dirk Kabcenell** writes, "I've become a home owner! (Not so easy here in southern California). Otherwise, it's business as usual at Xerox." Congratulations! . . . **Douglas Foxvog** is employed at NIH in the field of computerized image processing. He married Ann Stark last year and they had a daughter, Liana Sonja, last October. Congratulations twice! . . . **Karen (Irwin) Chen** writes, "I am still in electrical engineering graduate school at Berkley, but I have passed the department qualifying exam so I will graduate within a year. I took a two-week vacation trip to Banff and Jasper National Parks this past summer. The scenery was fantastic. I enjoyed hiking in several regions of the parks, but most particularly enjoyed a hike up the Athabasca glacier. Things in Berkeley are the same—work, work, work!" . . . **Jim Schretter** and his wife Nancy have moved to Washington, D.C. After graduating from the Darden School at the University of Virginia, Jim is now a business consultant with Booz-Allen and Hamilton.

B. Anthony Isaac is general manager of operations for Basic Vegetable Products in Vacaville, Calif. "Basic is the largest dehydrator of onions and garlic in the world." . . . Remember, it takes a while for these notices to appear in print. If you sent yours in several months ago and have not seen it yet, don't despair—we're working on it.—**Alex Castaldo**, Secretary, 929 Mass. Ave. (12D), Cambridge MA 02139

76 5th Reunion

We have a variety of material from the mails. My apologies if any of it is dated.

From **R. A. Montante,** "I managed to buy off enough people, and am still out of prison." . . . **George Todd:** "Quit working for Schlumberger in April; now working for Arco Oil and Gas in Dallas, evaluating oil wells in Texas, Colorado, Alaska, and the Gulf of Mexico." . . . **Mark Crane:** "Barbara Ann and I moved to Colorado Springs in July. She is still with DEC and I have just started as distribution analyst in DEC's manufacturing facility here. Both of us are enjoying doing DEC work for M.I.T. here in the spring."

Tim Allen: "I am working with Dave Littleboy at Computer Corp. of America, and still hanging around M.I.T. taking a graduate course from time to time." . . . **J. Mark Deric:** "I am with my second company since graduation, working for Texas Instruments in marketing in the booming area of discrete manufacturing and process controls and systems. It's a great opportunity to be working directly on improving the world's industrial productivity. The career experience has been fantastic, too. Working out of Johnson City, Tenn. (nestled between the Smokies and the Blue Ridge Mountains, and home of the world's most beautiful women), I've worked on all aspects of operational marketing including the launching of a product line that will gross $3,000,000 this year. This high visibility marketing experience is in distinct contrast to my last job as a systems design engineer for United Technologies' captive systems house. Hamilton Test Systems. I have five patents pending for my work at Hamilton on the Elevonics 101, Otis' new fully computerized elevator system (covered in *Fortune,* September 22, 1980)."

Jerry Dausman is "now in the staff of the MAS department of the Washington office of Alexander Grant and Co. (CPAs). Before starting work I had a week to relax, and it just happened to be the week that Ronnie came to town. I sat on the corner of

12th and Pennsylvania Ave on January 20 and had a chance to wave to Ronnie and George. I spent the rest of the week at museums, like the tour of the FBI building. I looked real hard but couldn't find a single Techie on the ten most wanted."

I had the pleasure of both a letter and dinner with **Steve Pincus.** From his letter: "Am an assistant professor of mathematics at Duke University and have been in touch with several classmates. . . . **Raphael Scheen** is a resident in Miami after graduating from Einstein Medical School. One-hundred-hour work weeks aren't conducive to the rest of life. . . . **Dave Gabai** is on a National Science Foundation post-doc fellowship (mathematics) at Harvard for two years, to be followed by a three-year Benjamin Pierce instructorship at Harvard. He just bought a condominium and has become an avid folk dancer. . . . **Pat Diamond** is doing well as a physicist at the University of Texas, Austin. Work is going well."

Stephen McConnel reports, "Last March I spent two weeks in France visiting the university in Grenoble to discuss research there and at Carnegie-Mellon University in fault tolerant computing. On the way home, spent eight hours sightseeing in Paris (jogging through the Louvre, etc.). . . . hope to finish my Ph.D. this coming spring. Maybe then I'll retire and collect my pension??"

We have from **Marsha Lavoie** and **Larry Hardy** a combined missive. "Marsha is in her first year of the University of California at Berkeley-San Francisco joint medical program, an innovative five-year program leading to the M.S. in health and medical sciences from Berkeley and M.D. from San Francisco. In addition to the usual medical curriculum, the program emphasizes social and political issues in health care. Her ambition is to become a primary care physician and to incorporate methods of health promotion and preventive medicine into her practice. Larry expects to receive his Ph.D. in biochemistry from the University of California at Berkeley in the near future. He is trying to decide between a post-doctoral research position and an industrial research job."

The telephone: **Jeff Baerman** gave me a ring from St. Louis. He is comfortably ensconced at Barnes Hospital and is actually contemplating taking a real vacation, possibly to the Caribbean. Imagine, time for a vacation! . . . **Carol Steiner** gave me a call while she was in New York that resulted in your secretary making one of the longest trips uptown he has ever attempted. She is making good progress towards her Ph.D. in chemical engineering at Penn. We had not seen each other since graduation, and I am amazed to find that Carol has not changed one bit.

Jeff Baerman, M.D., has checked in. "I'm working my tail off in the coronary care unit. Basically, I'll be glad when my internship is over next June." Jeff is at Barnes Hospital, St. Louis, Mo. . . . From **Mike Sledder** a card from Mombasa, Kenya. "It is the middle of the night and I'm at one of the highland game lodges near Mt. Kenya. There is a salt lick here and I've been watching buffalo, bongo, rhino, and bushbuck come to sample. Earlier I was out on the savannah where I saw lion, impala, giraffe, zebra, gazelle, elephant, vultures, ostriches, etc. I am really enjoying Kenya. The cruise went well despite a lot of equipment breakdown. We had calm seas nearly all the way." (Mike has been on a geological survey cruise which took him to Kenya as one port of call.)

And from **Mark Koupal,** "After reading the column for five years, I decided to write. (*Secretary's note:* would that more of you not wait this long; don't be shy). After graduation from the 'Tute, I went to the University of Chicago Graduate School of Business. Two years later (after a summer off to visit Europe) armed with an M.B.A. in finance and accounting, I joined the audit staff of the Chicago office of Arthur Young and Co. (CPAs). But as of March 1, 1981, I'll be working for the Santa Anna, Calif., office and living in sunny Costa Mesa. Friends from M.I.T. and the University of Chicago have convinced me to try the West Coast. If living there is anything like vacationing there, I'll love it."

Raphael Blumkin gave me a ring and reported that he is "alive and well at Peat, Marwick, Mitchell (CPAs). The only problem is defrosting my brains due to the cold Chicago winds." . . . Also chatted with **Margaret Hainsworth,** who continues to do spectacularly well at IBM. In my opinion she is emerging as a "mover and shaker."

Erland van Lidth de Jeude is back from Sri Lanka. Turns out he was fired from the film by John Derek (Bo's husband). Erland does not want to make a career of being bald. Can't say I blame him. On a cheerier note, he got a two-page spread in *People* magazine (February 23, 1981), including a great full-page picture (with all his hair). With any luck, he'll soon be on Johnny Carson.

As for your secretary, he continues to look forward to the reunion. Insofar as the markets are concerned, he did well during the crash of the gold market. Quite well. However, as I pen these notes on a Sunday evening, I know I am going to be losing a goodly portion of my shirt in less than 30 seconds when GNMAs start trading at 9:00 a.m. Monday. It is very fortunate that we had such a good group of short gold trades. Fear not, classmates, the windows on the 98th floor of 1 World Trade do not open. I'll make it to the reunion.—**Arthur J. Carp,** Secretary, Sandro Rohstoff, Inc., 1 World Trade Center, Suite 9853, New York, NY 10048

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Amalendra Arulpragasam writes, "After one year at Stanford University, I am now doing statistical analysis and modeling in the bond market and trading stocks and bond. Our three-man company has existed for two years in Palo Alto and will be moving to Wall Street in March." . . . **Peter Rives** is graduating from medical school May 1981, and will be pursuing a career in family practice. . . . **Richard Smiley** is going to get his Ph.D. in organic chemistry from Columbia University during the summer of 1981. "Then I don't have the faintest idea what I'll do after that. I am open to suggestions."

Katherine Joseph has worked since graduation for Prulease, Inc., a subsidiary of Prudential Insurance Co., and is currently an investment manager with them. She says she was able to apply a number of Sloan School credits to B.U.'s graduate program and after two years on a part-time basis received her M.B.A. in September 1980. . . . **Jim Datesh** is working for Dacar Chemical Co. in Pittsburgh, Penn., as product coordinator for the Industrial Coatings Division. The division sells products to the steel and non-ferrous metals industry. . . . "I'm in my fourth year of graduate study at Northwestern University working towards a Ph.D. in organic chemistry and having a great time," says **Michael Gross.** Well, the Chicago area is definitely a good time.—**Doug McLeod,** Secretary, 1641 Smith St., Green Bay, WI 54302

78

Leading off this month's news is a letter from Doug and **Sharon King,** in Berkeley, Calif. They have joined the growing ranks of our home owner classmates—they bought a small two-bedroom house in Berkeley, with a "huge" backyard and, if I know Sharon and Doug, a large and sincere welcome mat. Sharon is working on a master's in computer science at San Francisco State University while teaching a class on Fortran to undergraduates. Doug left his job at Chevron and moved on to the Engineered Systems Division of FMC Corp. and will soon be pursuing his professional engineer's license. Of course, they are still involved in ballroom dancing.

Tapio Kuusinen is finishing his second year of a two-year training program at Weyerhaeuser in Tacoma, Wash. (Now you spell it.) Tap has been training in Environmental Technology and Energy Research. He spent last summer vacation traveling in England, where he spent much of his junior year. Also out on the west coast—**Jim Heeger,** writes from "the sunshine in beautiful Palo Alto" where he is attending Stanford Business School. . . . I ran into **Al Knauf** when he came back to visit the University of Michigan Law School for an important alumni event—a cocktail party. Al, who graduated from here last year, wrote me a note for this column. So, as well as I can decipher his drunken scrawl, here it is: Al "is working at Bond, Schoeneck and King in Syracuse, N.Y., but may end up in his firm's Ft. Lauderdale office. He is admitted to New York and Florida bars (ed.'s note: and quite a few in Ann Arbor and Cambridge). Al plays tennis weekly with **Jeff Rubenstein,** another former MacGregor D Entry resident. Jeff and his wife Tiny live in their home town of Cazenovia. He is a systems director or some such thing at Beep Page and United Radio in Syracuse."

Larry Gordon was recently promoted to U.S. regional product sales manager for the Memory Components Division of Intel Corp. in Portland, Ore. . . . **Jerrold Liebermann** writes to say that he is enjoying his third year at Stony Brook Medical School, despite the hard work and long hours. . . . **Berhard Alpern** got his master's in transportation and traffic engineering at the Technion (in Israel) last March. Then, in May, he married Neva Goldstein, and in July they moved from New York to Silver Spring, Md. Bernie is currently an associate with Barton-Aschmar Associates, a D.C. consulting firm.

Steve Richmond writes from Philadelphia, where he is an actuarial student at Reliance Standard Life Insurance Co. More importantly, Steve sings in a barbershop chorus, the Pine Barons (officially, the Cherry Hill Chapter of the S.P.E.B.S.Q.S.A.), who recently won the district championship. This means that they'll be competing in the chorus contest at the international convention in Detroit, next July (the world series of barbershop). Good luck Steve. . . . **Herman Marshall** "just finished a paper on X-bursters with the HEAO-B X-ray observatory group at Harvard." Herman says that he's getting tired of bursters and is moving onto quasars for his thesis. Additionally, he's "having a wonderful domestic life with the wife."

From **Stephen Garrard:** "After staying on with my VI-A co-op company for a year (the Naval Surface Weapons Center), I moved back to Raleigh, N.C., and married my 'girl back home,' Aida Vincent. Such a classic story. Anyway, I now work for telex terminal communications here in Raleigh, where I'm developing IBM compatible computer terminals." . . . **Steven Norris** is conducting cancer research at the Cold Spring Harbor Labs—he's currently working of "the development of a computer data base for two dimensional electrophoresis analysis of cell proteins." . . . **Jill Kern** is back in Augusta, Ga., writing every day and keeping the four cats company. She is still working at Babcock and Wilcox, Insulating Products Division, as a quality asssurance engineer and is very active in the American Society for Quality Control.

Eric Umland got married to the former Jaye Schoengold last October. Present were Steve Garrand and Bill Scott, '75. Eric is working on his Ph.D. in physics at Rice University in Houston. . . . **Robin Schlinger** and **Fern Crandall** shared an apartment in New Jersey for two years; however, the long commute for both made this difficult, so Fern moved north and Robin moved to Edison, N.J. Robin writes that she is still working for Mobil Chemical Research and Development and that she has been active in young alumni affairs in the New York area.

This month's weirdest note comes from **Dick Field.** I quote in full. "To Limp, keep going strong. To Nino, how's Phil Lately? Oh! Hogan's are hers. Blome to NRSA. I got my M.S.M.E. and am at CV in Bedford, Mass. CAD/CAM it!" Don't ask me.

Julie Keller, while a student at the University of Minnesota Medical School, has been very active in working to convince the U.S. government to move to a liberal, rational policy concerning our government's aid to the military junta in El Salvador. I join Julie in urging all of you to call for a halt of our aid to the fascist elements in that country. For more information, write to Julie Keller (care of me, if you wish), and then write to the president, your representatives in Congress, and to the press.

Jill Kern is working as a quality assurance engineer at Babcock and Wilcox in Augusta, GA. Both Jill and her husband Jeff Grossman hope to return to M.I.T. this fall to go to the Sloan School. . . . **Alan Marcum** writes that he is spending a lot of his spare time riding his bicycles (a solo and a tan-

dem), competing and practicing his rifle shooting and fixing up the new house that he bought. . . . **William Lull** writes that he recently left his job at the TVA to begin working for Dubin-Bloome Energy Consultants in New York City. . . . **Renee Roy** got her master's in food science in December; she's now working at Pillsbury.

This is the time of year for graduations . . . first I'd like to send my congratulations to the M.I.T. Class of '81, graduating this June. Remember our senior year—those dumb turkey frosh? Well, they're alumni now . . . will wonders never cease. From the Class of '78, a warm welcome—don't forget to turn your Brass Rats around.

Some of our classmates are graduating from grad schools this month as well. **Ruth Shragowitz** wrote to tell me that she was graduating from the University of California, Berkeley's Graduate School of Architecture with a master's. In her "brief, but informative notice of my whereabouts and goings-on," she mentioned that she was dividing her last semester's time writing her thesis and teaching a section of an undergraduate design course. She is also dabbling in folk dancing, weather watching, improving her cooking, and even ice skating. . . . Also graduating with Ruth is **Rich Perlstein**. . . . **Steve Lawrence** is graduating this May from the University of Michigan Law School. After graduation, Steve will be returning to his native Cleveland to work for a medium-large law firm.

Also (possibly) graduating from the University of Michigan Law School is your humbled secretary. As I reported last month, I'm suffering from a case of senior-itis: I don't know where I'll be living next year or what field I'll be working in. And my girlfriend is going to Japan for a year. Well, at least the weather is getting nicer. Some letters from some of you would be helpful. (How is that for tugging at the old heart strings?) Until next month, then, this is your news-hungry class secretary—**David S. Browne,** c/o Neilsen, 293 N. Broadway, Yonkers, NY

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Greetings! By the time you read this, I should have ascended (hopefully!) from student to gainfully employed. More to come on that score later.

Michael Brzustowicz made that transition recently. After receiving his M.S. in computer engineering from Carnegie-Mellon last July, he started work with Bell Telephone Labs "doing operating system development on the internal version of the Unix™ Operating System. I spend my spare time trying to flee New Jersey!" Michael, however, plans a return to academia—he is applying to grad school for a Ph.D. in artificial intelligence. He is also involved in introducing high school students to computers through an Explorer Post. . . . Also working for a doctorate is **Paul Finman,** whose Ph.D. in electrical engineering at Stanford is being financed by Hughes Aircraft. . . . **Scott Kukshtel** also hopes to finish his M.S. in May. After he leaves the University of North Carolina at Chapel Hill, he hopes to find work back in Boston. "Any job offers?" he asks. . . . **Richard Bryant** got his M.S. in civil engineering in December from Berkeley. Says Richard, "I regret to inform all of you who knew her that the Blue Max passed on this year."

Daniel Jaffe graduated M.I.T. in February 1979, then took a climbing/sightseeing trip to Asia, Australia, and New Zealand. He is now in his second year as a public high school chemistry teacher in North Andover, Mass. . . . **Michael Amadeo** spent a year in Houston as a consultant for Data Resources, Inc. However, disgusted with the hot weather, he moved to Arlington, Mass., to work on the programming staff at DRI's Lexington headquarters. He reports having since "fallen in love with my true calling, Course VII!" Mike is rooming with Kate Mulroney, '80 ("platonic"). In his spare time, he is "writing a book about various people and happenings at M.I.T., and planning out a cross-country trip this summer, my third."

Charles Eliot writes from the University of Oxford (that's England), where he is a Ph.D. candidate in biochemistry. "Very short hair, spectacles, and an earring (pierced, of course). You wouldn't recognize me! Ph.D. thesis plugs along (H2O organization in cell systems as studied by NMR). English weather sucks. Music scene very energetic and rewarding. Doing a lot of acting and working—and indulging in concerts by Bauhaus and the Modettes!"

At this writing, chemical engineer **Eileen Mannix** plans an April 1 starting date for her new assignment at duPont's Spruence plant in Richmond, Vir. Eileen will be greatly missed by the many Wilmington (Del.) area theatre and choral groups to whom she has lent her many talents, not to mention by this reporter! . . . **Hy Tran,** who was mentioned in a recent column (info thanks to Eileen Mannix), writes that his new home, Kennett Square, is the "Mushroom Capital of the World"! (Don't ask me, I only report the stuff!)

Just thought of some freshman-year friends that I haven't heard from yet. Sharon, Don, Roger, Audrey, and Dan—you'd better write soon! See you all next month—**Sharon Lowenheim,** Secretary, 98-30 67 Ave., Forest Hills, NY 11374

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Believe it or not, it's a big month for news, so, without further ado . . .

Back in November, I ran into **Joan Solomon,** who was directing a Dramashop one-act play on the M.I.T. campus. At the time, Joan was also doing some consulting work in Boston. A recent letter from her indicates that she is now working for a consulting firm in Washington, D.C. This, too, is only temporary. Joan will be going off to the Wharton School of Business in the fall for an M.B.A.

People still hanging around M.I.T. include **Valerie (Kaufman) Farber** who is working toward a master's degree in metallurgy for this June. Valerie is also working at Draper Lab. . . . **Peter Lemme,** seemingly reluctant to leave M.I.T., is also working on his second degree, this one in the Department of Aeronautics and Astronautics. Pete is continuing to play an active role on campus, working very closely with the Athletic Association.

The recent Chinese New Year brought several M.I.T. alums together to celebrate in the Big Apple. **Lin Chao, Diane Gorczyca, Bruce Chung,** Dan Lu, '79, and Sandy Tong, '78, met "to browse along 5th Avenue." Lin is an electrical engineering graduate student at the State University of New York at Stony Brook. Diane and Bruce are both in medical school, Bruce in Detroit (Wayne St.), and Diane in Albany. Also at Albany Medical College are **Michele Piccone** and **Nolan Kagetsu.** Diane proudly proclaims, "We've survived our first quarter of courses here and are now one-eighth M.D.s!" After sampling the medical school workload, she is already starting to look back on her M.I.T. education as "the good ole' days!"

Our esteemed (?) class president, **Chuck Irwin,** has finished chemical engineering practice school and is now working for Rohm and Haas Co. in Bristol, Pa. . . . **Kim Zaugg** is now going to school at State College, Pa. Kim is one more alumnus who became an M.I.T. Educational Counselor. In the Boston area in November, Kim checked out the new ice rink and was suitably impressed.

Statistics quote a very large percentage of M.I.T. graduates who stay in the Boston-Cambridge area. I am beginning to believe the statistics as I continue to run into classmates both on campus and off. **Craig Goldman,** having obtained an M.I.T. master's degree in computer science this past January, has now gone to work for PR1ME Computer in Framingham. . . . **Steven Stern** is a student just up the creek at the Harvard Medical School. . . . **Mary Rorabaugh** is doing financial consulting work for Putnam, Hayes, and Bartlett in Harvard Square, and living in Medford. . . . **Steve Berez,** also living in Medford, is doing consulting work in Boston for Bain and Co. . . . A letter from **Connie West** in Watertown reports that she is working for Dynatech R/D consulting, and has become a suburbanite. She is looking forward to going back to school. Meanwhile, she has been spending much of her time traveling in the New England area, hiking, and playing field hockey for the Boston team.

David Plotnick writes that he has a wonderful job running research projects for the Association of Health Maintenance Organizations in Washington, D.C. Dave sounds quite content with his new location: "The winter is much milder than Boston winters," (how can you miss?), "the research projects are interesting, and I work with really nice people." . . . **Michael Waxer** is in Los Angeles doing solar architecture work for the Watts Labor Community Action Committee. Is solar architecture really possible in L.A., Mike? . . . My sources tell me that **John Maginnis** is also on the West Coast. John is a Stanford graduate student, studying math and frisbee. . . . **Tim McManus** is doing graduate work at the University of Maryland. . . . **Katie Gropp** is at veterinarian school at the University of Miami in Florida.

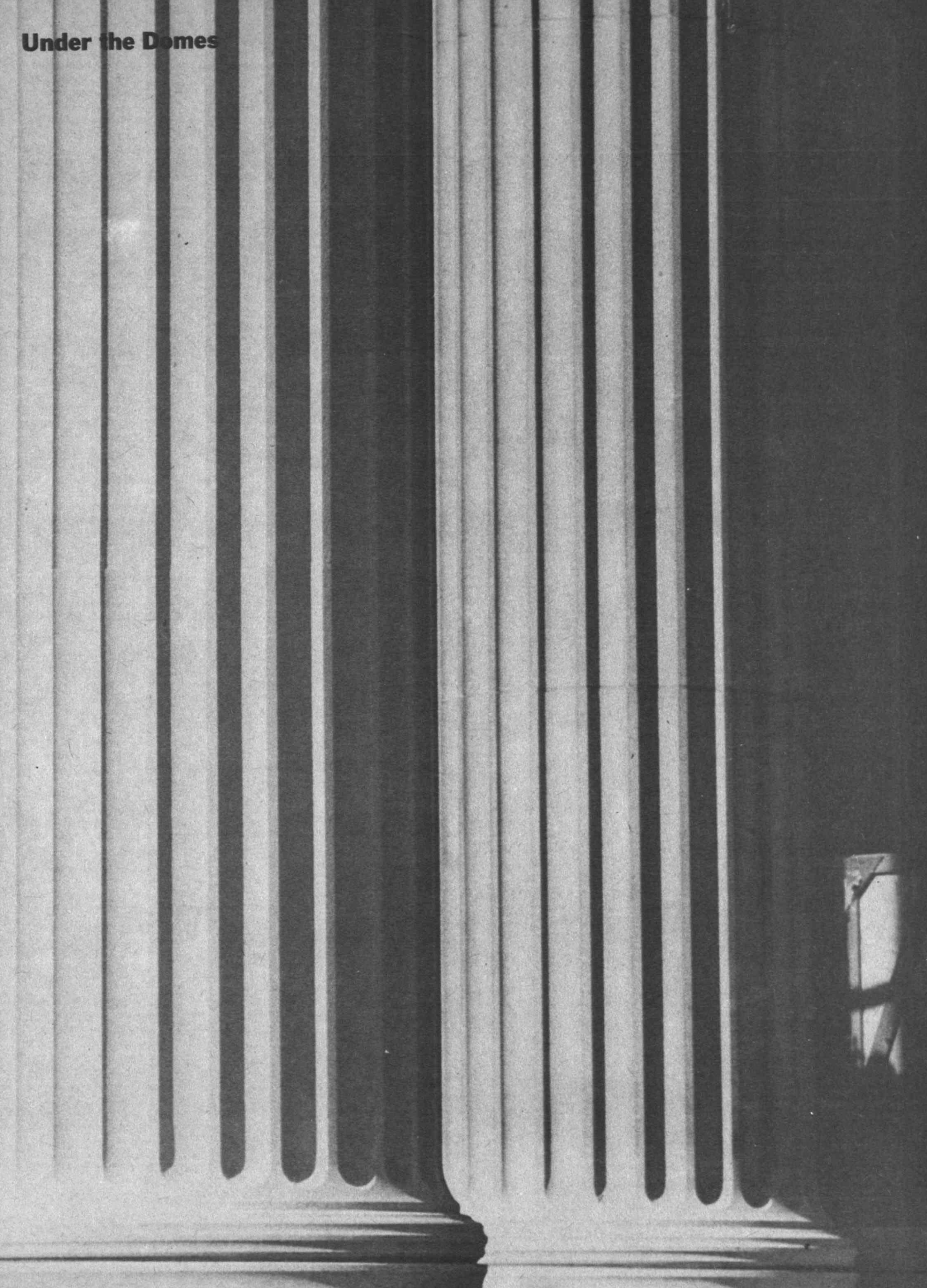
A letter from the brother of **George Morrison** indicates that George is in the Department of Civil Engineering at Carnegie-Mellon University in Pittsburgh. . . . **Paul Homsy** is currently enjoying his first year as a med student at the University of Texas Medical School in Houston. He very graciously invites any "M.I.T. folk" passing through Houston to contact him.

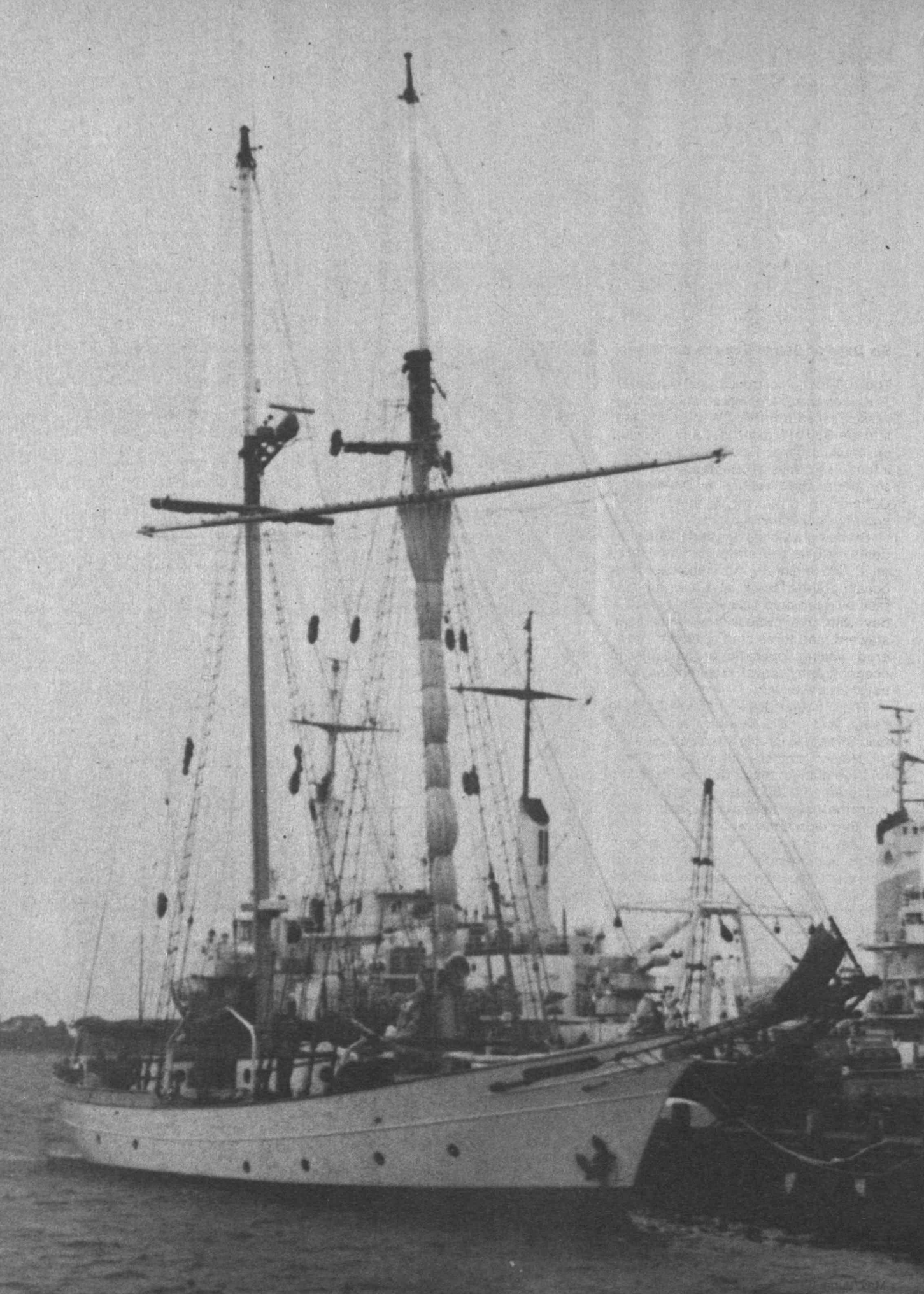
As I requested several months back, some people are finally starting to spy on their friends for me. **Jim Garcia** sent me one such anthology, with a look at what some of the Class of '80 ROTC graduates are up to. Jim is a second lieutenant (2LT) in the Army, stationed in Schweinfurt, Germany, a scant 35 kilometers from the East German border. . . . 2LT **Gary Smith,** having spent six months with Jim in training in Aberdeen, Md., is now stationed in Wildflecken, Germany. . . . **Tim Easterly** and **Jim Showalter** were also at Aberdeen. Tim is now in Korea for a year. . . . 2LT **Ken Oya** is at Fort Riley, Kans. . . . 2LT **Charles White** and **Ryang Lee** are both at M.I.T. working on master's degrees in mechanical engineering. . . . **John Walsh** is working for a mechanical engineering firm in Burlington, Mass., and living near Harvard Square. . . . Before signing off, Jim asked me to convey the message that Germany is a fine place (particularly Schweinfurt), and he urges people to look him up if they are in the area.

Despite Jim's efforts, this issue's letter of the month comes from **Matt Steele.** Matt just received an S.M. in management from M.I.T.'s Sloan School. He is now gainfully employed as a cash analyst in the Treasury Department of the Finance Division at the Getty Refining and Marketing Co. in Tulsa, Okla. (Whew, almost didn't get that out in one breath!) As for some of Matt's friends, **Andy Miller** and **Steve Neustein** are both slaving away at medical school in Manhattan. Andy is at Cornell, and Steve is at Columbia. . . . **Matt Hogg** is at the University of Chicago in a Ph.D. program. . . . **Bennett Leeds** is at the University of Southern California Film School in the master's program. . . . **Mike Sider** is working in Manhattan. . . . **Jean Wisner** is in a chemistry Ph.D. program at Northwestern University. . . . **Joel Fajans,** also a Ph.D. student, stayed at M.I.T. to study with the physics department. . . . **Lisa Jungherr** is also at M.I.T. Lisa is in the master's program in the Department of Chemical Engineering. . . . **Robert Adu-Gyamfi,** having gotten his S.M. in mechanical engineering over the summer, is now working at Digital Equipment Corp.

As for myself, I have recently started work at Bolt, Beranek, and Newman Information Management Corp. in Cambridge. Among the people I work with is **Curt Sanford.** (Work "with" is using the term loosely; a more accurate statement is that I ask questions and Curt answers them!) Our current project is a commercial electronic mail and filing system. Walking around the rest of BBN, I seem to run into a lot of people with brass rats. Is this really getting away from the 'Tute?

Before closing, I would like to apologize to anyone who has written and then spent a long time waiting to see his news in print. The *Review* production schedule and the lag in the information getting to the right place at the right time sometimes causes a time lag of up to four or five months! Thanks to all for your encouraging words, anyway. I will continue my sacred duty to print all sorts of dirt, as long as you continue to send it to me.—**Ken Turkewitz,** Secretary, 241 Lexington St., Bldg. 15, Apt. 2D, Woburn, MA 01801





Six Days At Sea to Explore the Ocean

The 100-foot, 250-ton staysail schooner *R.V. Westward*, a research and training vessel, sailed from Key West in Florida into the Gulf of Mexico last January with an unusual cargo—19 M.I.T. students intent on six days of orientation to life at sea under the direction of Douglas A. Carmichael, professor of meteorology and physical oceanography.

Standing watches day and night, students helped the staff operate, navigate, and maintain the ship, collected oceanographic data, and carried out their own projects. Classes, held twice a day with five professional officers, a steward, and three staff scientists, covered sailing operations, navigation, oceanography, naval architecture, and naval archeology.

Their course was first west, then south, and finally eastward across the Gulf Stream to land in Miami on January 15. Heavy weather—force 5 to 7 winds and the coldest temperatures recorded in the area in 100 years—caused more than the usual seasickness and chills. But that didn't matter.

They had been duly warned, in their instruction manual: "Life at sea and active participation in seminar activities require sound physical conditioning. Accommodations are spartan, with little privacy and occasional discomfort. Weather conditions are rarely ideal.

"However, the opportunities of a shipboard seminar provide a rare adventure, comradeship that is unique to large sailing vessels, pride in accomplishment, simple but excellent food, and in addition, a great deal of fun." Students agreed.

"Subjects normally only read about were experienced," explained Barbara Wesslund, '84. She was amazed at the phosphorescent algae in the water the first night on board—the experience, like so much of the week, was a far cry from reading about it. "The sunsets, the sunrises (which saved the 0300-0700 watch), the sea, the laboratory work, the crew, and the students made the trip exciting and memorable."—*M.L.*

The Westward *(opposite page) is a 250-ton steel auxiliary-powered staysail schooner built in 1961. She is a long-range deep-sea vessel which annually logs 20,000 miles in 280 scheduled days at sea. She is 100 feet on deck, 22 feet wide, and draws 12 feet of water. She can spread more than 7,000 square feet of sail, and her main engine is a 350-horsepower diesel. Not a bad laboratory for 19 M.I.T. students during a week in Florida in January.*

Left: Barbara Wesslund, '84


A.N. MacDonald


J.G. Gavin


C.J. Matthew


A.P. Hildebrandt


R.A. Jacobs


S.J. Losh


G.W. Moore


J.W. Taylor


H.P. Aldrich


E.M. Drake


G.M. Keller

Angus MacDonald Is Alumni President; Other Officers Listed for 1981-82

Angus N. MacDonald, '46, who has been active as a member of the M.I.T. Corporation and several of its committees during the last decade while building a successful consulting business in corporate mergers and acquisitions in Greenwich, Conn., will be president of the Alumni Association in 1981-82.

In addition, Norman B. Leventhal, '38, chairman of the National Selection Committee, has announced other new officers who will work with Mr. MacDonald as new members of the Association's Board of Directors beginning next July 1:

☐ **Joseph G. Gavin, Jr.,** '41, president of Grumman Corp., vice-president for 1981-83.

☐ **Christian J. Matthew,** '43, assistant administrator and director of development at St. Mary's Hospital and Medical Center, San Francisco, vice-president for 1981-83.

☐ **Albert P. Hildebrandt,** '44, chairman of the board of Mayhill Homes Corp., Gainesville, Ga., director (District 7) for 1981-83.

☐ **Richard A. Jacobs,** '56 vice-president and director of A.T. Kearney, Inc., management consultants, Chicago, director (District 6) for 1981-83.

☐ **Samuel J. Losh,** '54, a member of the management staff at Xerox Electro-Optical Systems, Pasadena, director (District 9) for 1981-83.

☐ **Gordon W. Moore,** '60, marketing representative (Denver) for ITT Business Communications Systems, director (District 8) for 1981-83.

☐ **James W. Taylor,** '55, employee relations planning manager for Exxon Enterprises (division of Exxon Corp.), New York, director (District 3) for 1981-83.

Three alumni have been nominated for Term Membership (five years, beginning July 1, 1981) on the M.I.T. Corporation:

☐ **Harl P. Aldrich, Jr.,** '47, co-founder and president of Haley and Aldrich, Inc., consulting geotechnical engineers and geologists of Cambridge, Mass. Dr. Aldrich is president of the Alumni Association for the current year (1980-81), and next year he will be chairman of the Corporation's Visiting Committee to the Department of Civil Engineering.

☐ **Elizabeth M. Drake,** '58, vice-president of Arthur D. Little, Inc., Cambridge, where she is manager of the risk analysis group specializing in safety evaluations related to the processing, storage, and transport of hazardous materials. Dr. Drake and her husband, Professor Alvin W. Drake, '57, were faculty residents at East Campus for seven years; she has taught chemical engineering at M.I.T.; and she is currently a member of the Corporation's Visiting Committee to the Department of Chemical Engineering and president of the alumnae corporation for the Women's Independent Living Group.

☐ **George M. Keller,** '48, chairman and chief executive officer of Standard Oil Co. of California—the firm which he joined upon graduating from M.I.T. in chemical engineering. He is now a member of the Corporation's Visiting Committee to the Department of Chemical Engineering, and he is also a director of the M.I.T. Club of Northern California.

Mr. MacDonald, who will assume the presidency of the Alumni Association on Technology Day next June 5, studied aeronautical and mechanical engineering at M.I.T. and then for four years worked on nuclear energy for aircraft propulsion for the Fairfield Engine and Airplane Corp., at Oak Ridge, Tenn. He formed his own company in 1970. He is currently a member of the Corporation's Visiting Committee to the Departmen of Aeronautics and Astronautics, of which he is a former chairman; of the Council for the Arts at M.I.T.; of the Visiting Committee on the Arts; and of the Development Committee; and he is a life member of the M.I.T. Sustaining Fellows.

An error was made in reporting the winners of the M.I.T. College Bowl. They are the Fishheads: Jay Pattin, '83, Susan Cohen, '81, Joe Romm, '82, and Fred Helenius, '82.

B.F. Smith

Taking Aim on 1,050 for the Class of 1985

Admitting a new class at M.I.T. is a "little like sailing when there's no wind blowing," Peter H. Richardson, '48, told *The Tech* this spring: "You have to look around and make a guess."

The process was in full flower by the end of March, when the Academic Council told Mr Richardson that the Class of 1985 should number 1,050 students. That's the same target as was set for the Class of 1984, for which 1,056 students actually registered last September.

The severe dormitory overcrowding of 1980 is not expected next fall because a new dormitory at 500 Memorial Drive will be ready for over 300 students.

The Class of 1985 will be selected from 5,893 applicants—an increase of 4 percent over last year, Mr. Richardson says. Of these, 1,176 are women—a welcome 9 percent increase over 1980 and the largest single increase in the number of female applicants to M.I.T. in the past ten years. Minority applications (blacks, Mexican-Americans, Indian-Americans, and Puerto Ricans) were up only 1 percent.

Next year's Student Budget Is $11,700; Are We Becoming the Massachusetts Institute of Taxation?

The average student will spend at least $11,700 to attend M.I.T. next year.

That breathtaking total includes tuition of $7,400, up nearly 20 percent from 1980-81; $3,180 for housing and food (up 14 percent); $350 for books; and $770 for other expenses—probably not including travel. It's the highest total—by a hair—announced by any university as of the end of March.

Having determined this "typical" budget, the Office of Student Financial Aid established $3,400 as the "equity level"—the amount (including loans, savings, and term-time jobs) which students and parents must provide toward educational expenses before scholarship assistance becomes available.

Students were quick to note that most of the components—and therefore the total—of next year's budget went up faster than the country's 1980-81 rate of inflation; but most seemed resigned to once more digging deeper into their pockets and adding once again to their post-graduation debts. "Would that it was possible for ordinary, mortal freshmen to understand the complexities of finance at the Massachusetts Institute of Taxation," wrote James MacStravic, '84, in a letter to the editor of *The Tech*.

A few students proclaimed that this was one step too much; they would withdraw, "M.I.T. is rapidly becoming a school for the elite wealthy, not the academically advantaged," wrote Brad Wright, '84, and "I'm afraid I can't afford this expensive playground."

Forecasting the Force of Reaganomics

Most of the first initiatives from President Ronald Reagan's economy-minded White House sounded grim for higher education—and for M.I.T. especially. Nothing was approaching firmness by press time, with negotiations and congressional decision making pending everywhere, but threats to research support—including the Sea Grant Program—and student loans were the most worrisome.

Some 3,500 M.I.T. students benefit from the federal Guaranteed Student Loan program in which cuts have been recommended, and in response to local concern Jack H. Frailey, '44, said at a General Assembly meeting early in March that the Institute "would provide the funds necessary" to keep loan-dependent students at M.I.T. But Leonard V. Gallagher, '54, director of student financial aid, noted that the $10 million which M.I.T. students annually borrow under GSL program "is far beyond M.I.T.'s ability to match dollar for dollar."

New York Regional Director

B. Frank Smith, M.Arch.'68, who turned to alumni relations work at Tulane University two years ago after practicing and teaching architecture for seven years, will become regional director for New York of the M.I.T. Alumni Association early in May. In that assignment his responsibilities will include Alumni Fund and alumni relations activities in the three-state New York metropolitan area, based in the M.I.T. Alumni Center at 50 East 41st Street.

From his work as director of Tulane's Office of Alumni Affairs since January 1979, Mr. Smith says he is convinced that "educational quality" should be the basic focus of alumni relations activities. Given this emphasis alumni affairs are "an important opportunity (for a university) to extend itself beyond its immediate physical boundaries."

Mr. Smith came to M.I.T. in 1967 after receiving his undergraduate degree in architecture at Tulane. His work at M.I.T. was in the field of housing and community design, leading to work in two Boston architectural offices and finally to a Fulbright-Hayes Scholarship to Spain for 1970-71. Thereafter he taught architecture for four years at the University of Kansas and then returned to his alma mater as assistant professor and assistant dean of the School of Architecture.

New Master's Degree to Prepare Engineers for Management

A new master's degree in the management of technology will be given for the first time in June, 1982, and the first class of ten graduate students will enter the program in the Sloan School this June. The idea, says Professor Edward B. Roberts, '57, is to prepare engineers and scientists with five or ten years' experience on technical projects "for career paths requiring managerial responsibilities." The planned final size—40 to 50 students—will be reached by 1983-84, Professor Roberts said.

Technical Education: Influences Beyond the Classroom ▸

"The students who move in a highly technical world, constantly using mental gymnastics to solve puzzles, begin to link their sense of worth as human beings with their cognitive ability. Like dancers, if they can't exercise that competence they feel restless and flabby."

Dr. Benson Snyder, director of the Division for Study and Research in Education, made an intensive study of the class of 1965 as students. Now he has returned to follow them through their careers: How have their technical studies influenced the choices they have made in life?

The study is now in preliminary stages, but he has some insights into the kinds of problems that a technical education might engender:

It is as if students who have moved into various fields have moved onto different islands, he says, with different notions of causality (shared by that island) and different languages. The differences between physics students and math students are reflected in their speech, the way they think, the metaphors they use. Both tend to stay away from situations where there is a high level of noise and uncertainty instead of right or wrong answers—the world of human beings. Yet they often achieve managerial positions, where they are dealing with people.

The primary focus, he says, is to trace out highly technical cognitive development, to learn how issues apparent in adolescence are worked out in that setting. "I sense that a number of these people tend to put attention and energy into intellectual concerns while neglecting others. What happens when someone (and this is not unique to science and engineering) lives in a psychological space most of the time (such as solving technical problems for example) which is *not* something they can share with their parents or spouse?

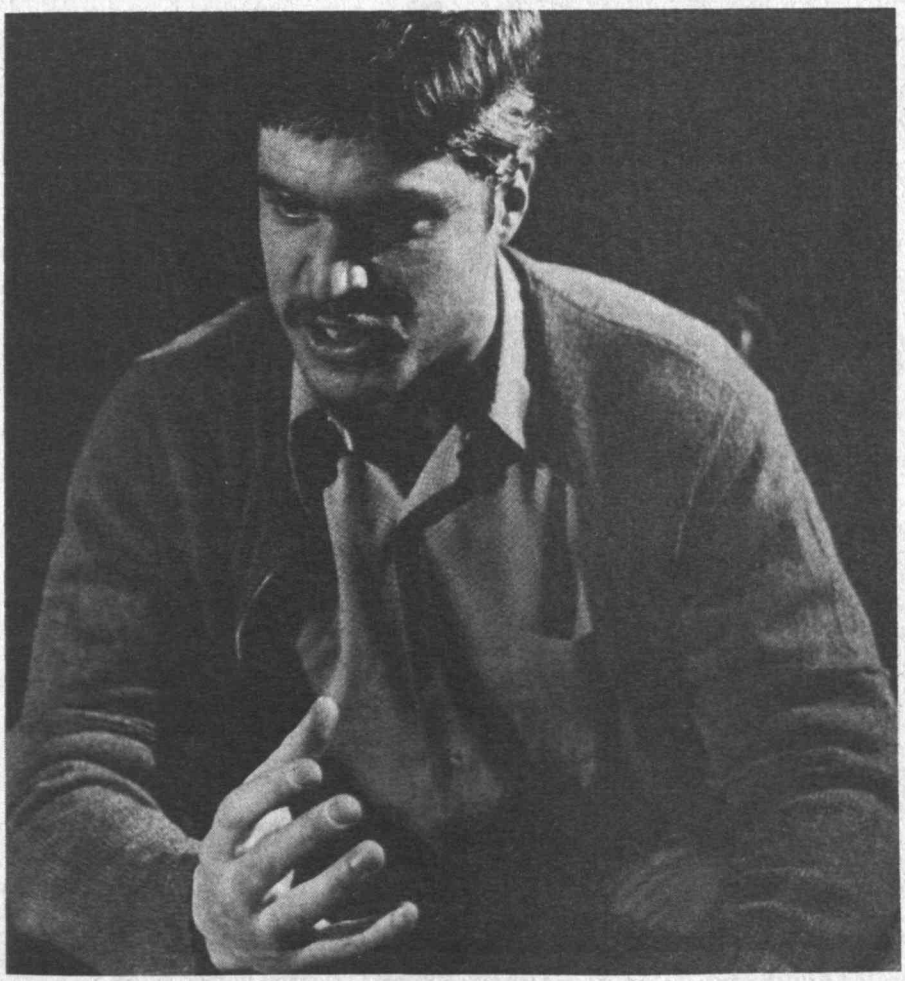
The rate of change in some of these disciplines (computer science, for example) is so rapid that several people who have made significant contributions already feel obsolete. They feel like high-wire performers who must be up there all the time, balancing as they reach higher and higher, never able to come down, he explains. Professor Snyder expects to continue his interviews in the summer and fall and to compile his information into a modest book.—*M.L.*

Anne Frates and Dana Martel (right), and Charles Frankel, '82 (below), in A View from the Bridge *by Arthur Miller, performed by the M.I.T. Shakespeare Ensemble.*

A View from the Bridge Is Presented by the M.I.T. Shakespeare Ensemble

This spring the M.I.T. Shakespeare Ensemble will revive its production of Arthur Miller's *A View from the Bridge* during Alumni Weekend, June 4 and 5 at 8:30 p.m., and June 6 through 9 at 8:00 p.m. in Kresge Little Theater.

The play opened in early spring last year at M.I.T., and the Ensemble then took it on a successful tour of Great Britain last summer. Most of the original cast will be in this spring's production.



The Shakespeare Ensemble is a group of M.I.T. and Wellesley students devoted to extensive study and performance of Shakespeare's plays. Under the guidance of Ensemble director Murray Biggs, the group has been touring the northeastern United States with its productions of Shakespeare for several years. For its first foray into foreign waters, however, the Ensemble decided to take advantage of its developing second line in American drama, and thus show British audiences a lesser-known play by a major American playwright performed by young American actors. *A View from the Bridge* was all the more appropriate a choice because of its traditional style and references to Greek tragedy, which Arthur Miller stated were best handled by actors with classical training. The British tour was a solid success, playing to appreciative audiences in London and throughout the countryside, and garnering praise from the British national press.

The revival features Ensemble veterans Charles Frankel and Anne Frates in the lead roles, and is directed by Murray Biggs. Ticket prices are $5.00 for Friday and Saturday and $4.00 other nights, with a $1.00 discount for students. For reservations and other information, call (617) 253-2903.—*Thomas V. Garvey, '82*

M.I.T. INSIGNIA

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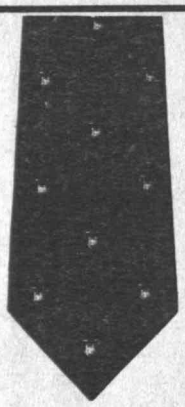

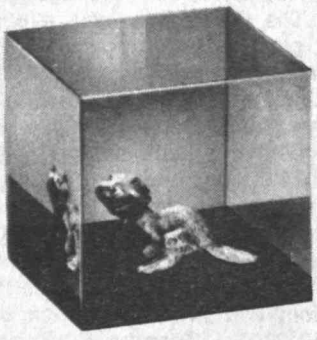

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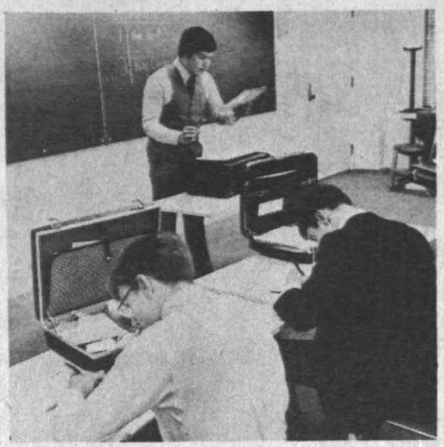
ALL PRICES SUBJECT TO CHANGE WITHOUT NOTICE

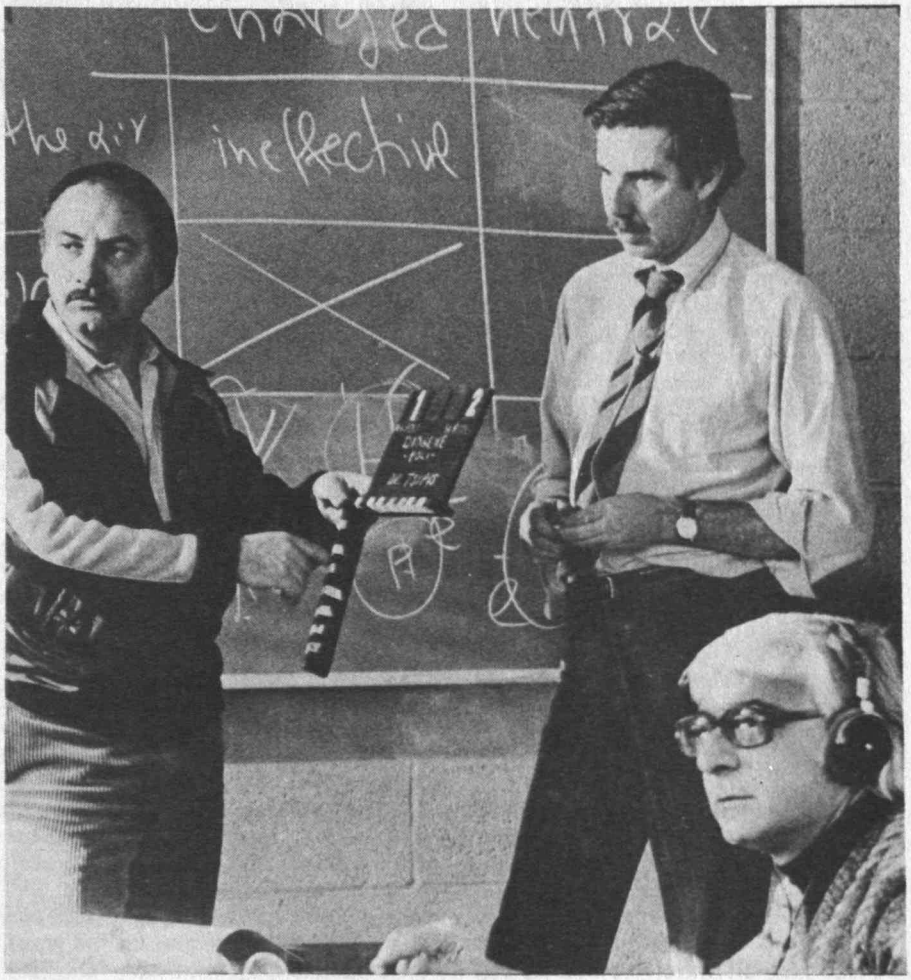
Clockwise from top: Debater Michael Giannitti of Bates College argues his case during a debate tournament held at M.I.T. Jeff Kralowetz and Shawn Hunter of the United States Military Academy team take notes in preparation for their rebuttals. The tournament, which drew 31 teams from 16 schools, was sponsored by the M.I.T. Debate Society.

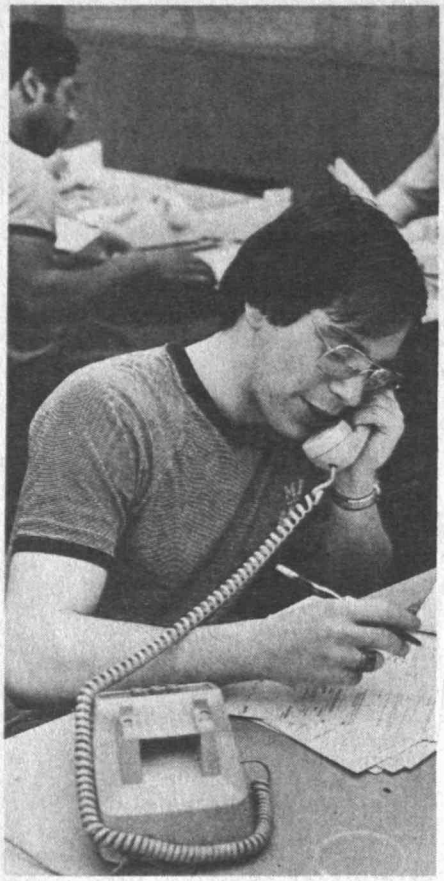
Irwin Welber, left, executive director of Transmissions Systems/Merrimack Valley of Bell Laboratories, presented a check for $118,000 to President Paul E. Gray. The check, which matches tuition, is for unrestricted support of departments in which Bell Labs employees are enrolled.

Kosta Tsipis, research scientist with the Program in Science and Technology for International Security, right, prepares to face the camera during an interview by Italian national television. Dr. Tsipis discussed his research on the particle beam weapon which he opposes as physically impossible.

Dedication of the George Russell Harrison Spectroscopy Laboratory last March began with a special symposium. Speakers were (left to right): Nobel laureate Dr. Gerhard Herzberg of the Herzberg Institute of Astrophysics of the National Research Council of Canada; Dr. Charles H. Townes, Nobel laureate and University Professor of Physics at the University of California; and Edwin H. Land, chairman of the board of the Polaroid Corporation. They are with M.I.T. Provost Dr. Francis E. Low, who presided at the symposium. (Photos: Calvin Campbell)







Photos: Mark Sloan, '81

Telethon: Students Call 5,700 Alumni

Over 340 students participated in the Alumni Fund third annual student telethon during 12 nights last winter. They represented all of the dormitories and 17 fraternities (above: brothers of Zeta Beta Tau, winners of last year's "Grand Prize"). They called 5,700 alumni in the United States and Canada, and secured commitments from 3,225 alumni totalling almost $81,000. This is the single largest personal solicitation effort of the Fund.

Benfits for student volunteers ranged from talking with alumni who are out in the real world to prizes of dinners and passes donated by local vendors. Some of the students even received offers of summer jobs. A Grand Prize of $100 cash was offered by the Alumni Fund to the living group with the highest number of callers and pledges. The prize was won by Burton House which narrowly edged out Baker House in the final hours of the telethon.

Electrical Engineering Enrollment More, Faculty Less

Electrical engineering at M.I.T. is up against the wall—too many students, not enough faculty, not enough space, not enough teaching assistants.

Professor Donald E. Troxol, Ph.D.'62, had to close the doors to his introductory laboratory course on digital systems because there were only 190 lab kits available; he accepted all graduate students and seniors who wanted to attend and conducted a lottery for the remaining places among juniors and sophomores, assuring those who didn't win a place in the class next fall.

Steven M. Weiss, '81, was among several students refused registration in another electrical engineering course; "I'm quite disenchanted," he told Barry S. Surman, '84, of *The Tech*. "It's not a good way to run a . . . school."

Professor Arthur C. Smith, the department's graduate officer, agrees that it's "an impossible situation in which we cannot meet all our responsibilities." Some statistics from Professor Richard B. Adler, '43, associate head of the department: the ratio of undergraduate students to faculty in electrical engineering was 5½ to 1 in 1970; last year it was 10 to 1. Enrollment has gone up by 50 percent in that ten-year period but not the number of faculty and the budget; and even now there are faculty jobs and other teaching slots vacant because no qualified teachers can be found.

Affirmative Action: Some but Not Enough

In 1970, only 17 women were members of the M.I.T. faculty; a decade later, the number is 93—good progress. But a comparable representation for minorities on the faculty has been elusive, with only 19 blacks and 12 Hispanics in 1980.

Constantine B. Simonides, '57, says that—while this progress toward affirmative action goals was comparable with that of other large research institutions—"We're not satisfied . . . We're going to step up the performance."

"You can't just sit around and wring your hands" over the lack of women and minorities qualified for faculty positions, Dean Shirley McBay told Stephanie Pollack, '82, editor of *The Tech*, when asked to comment on the issue. "You have to grow your own," she said: find ways to increase the number of black and minority students and then to persuade them to remain for graduate and postdoctral work and finally to join the faculty.

Renaming the Harvard Bridge: Non-Issue?

That move to rename the Harvard Bridge has fallen on hard times in the Massachusetts legislature. Peter Balbus, '81, told a hearing of the Joint Committee on Urban Affairs during the winter that the Harvard Bridge, "smack dab in the middle of M.I.T.," ought to be named accordingly. But Representative Sandra Graham of Cambridge stole his platform. The bridge and its name are a non-issue, she said. "The real problem is what the universities are doing to Cambridge. M.I.T. and Harvard . . . their expansion is destroying the neighborhoods."

Civil Engineers Identified

One of the missing names under the picture of the Department of Civil Engineering in 1930 is that of Leo Jurgenson, '26. And you mislabeled as "Wentworth" the picture of A. Wentworth Erickson, '28. The first name of the second unidentified staff member was Albert, and I believe he was from the New York Subway System, associated with the Soil Mechanics Laboratory.

Isadore Silverman, '28
Denver, Colo.

Kudos, People, and Places

Loren C. Cox, who has been executive director in charge of daily operations of the Center for Energy Policy Research, is now the center's director; his predecessor, Professor Henry D. Jacoby of the Sloan School of Management, becomes chairman of the center's Operating Committee. . . . **Steven L. Solnick,** '81, editor of Volume 100 of *The Tech*,

More than 100 M.I.T. graduate and undergraduate students, taking advantage of the new blanket M.I.T. student membership in the Boston Museum of Fine Arts, turned out for a reception at the M.F.A. sponsored by the Undergraduate Association and the M.I.T. Council for the Arts. (Photo: Calvin Campbell)

will be in England next year under a Marshall Scholarship. . . . **William Doyle,** '84, just back this spring from a week's tour of Tokyo and Kyoto, Japan, says he found Japan "more technologically oriented" than the U.S.; the trip was his prize for a 1980 U.S. Army International Science and Engineering Award. . . . **Paul Neves,** '83, confirmed his status as "one of the premier middle-distance runners in New England" this spring by winning 800- and 1500-meter runs in the New England Division III NCAA indoor track championships; he'll run in the national competition in May. . . . The Federation of American Scientists selected President-Emeritus **Jerome B. Wiesner** for its 1980 Public Service Award: "We all looked to Jerry for leadership (in) the struggle for arms control throughout the 1960s and found it. Now that he is freed from his heavy responsibilities as president of M.I.T., we want to find it again."

James A. Beatty, 1896-1981

James A. Beatty, '71, professor emeritus of physical chemistry who served on the faculty from 1923 until his retirement in 1961, died on February 23 at his home in Belmont. He was 85.

Professor Beatty entered M.I.T. in 1913, when the Institute was still in Boston. He continued after receiving his S.B. for master's (1918) and Ph.D. (1920) degrees in physical chemistry, and during the years thereafter he developed a strong interest in chemical thermodynamics. He was acting director of the Research Laboratory of Physical Chemistry in1942-43 and in 1979 was co-author with Professor Irwin Oppenheim of M.I.T. of *Principles of Thermodynamics.*

But these details seemed to Lawrence E. Beckle, '42, former director of the Center for Space Research, to miss the point; he wrote in *The Tech* of Professor Beattie's "great compassion and intimate concern for the welfare of his students . . . a compassionate and feeling gentleman," he wrote.

Robert A. Cuzick, 1957-1981

Robert A. Cuzick, Jr., a graduate student in the Department of Nutrition and Food Science, was a suicide victim in Hyannis, Mass., during the week-end of February 14-16. Mr. Cuzick, who was married but had no children, came to M.I.T. from the University of Colorado.

Deceased

Francis G. Baldwin, '06; April 17, 1978; P.O. Box 267, Sarasota, Ill.
Edward B. Rowe, '06; December 4, 1980; 2101 Washington St., Regency Hall, Newton Lower Falls, Mass.
Karl W. Richards, '07; January 29, 1981
Frank S. McClintock, '09; January 1, 1981 805 Amberson Ave., Pittsburgh, Penn.
Chester W. Wilson, '10; November 23, 1980; P.O. Box 35, Barrington, N.H.
Ralph E. Runels, '11; December 19, 1980; 140 Belmont St., Lowell, Mass.
Albert Harkness, '12; January 5, 1981; 5 Cooke St., Providence, R.I.
Gardner R. Alden; '13; December 15, 1980; 1711 Windsor Dr., Framingham, Mass.
Emerson L. Bray, '13; September 13, 1980; Lansdale Village #C-4, York and Green St., Lansdale, Penn.
Arthur W. Carpenter, '13; January 2, 1981; 943 Genesee Rd., Akron, Ohio.
Stuart J. Eynon, '13; October 24, 1980; 285 Webster St., Needham Heights, Mass.
Laurence C. Hart, '13; December 16, 1980; 1850 Folsom, Apt. #308, Boulder, Col.
J. Warren Lovell, '13; December 29, 1979; 1268 C. Eastern Pkwy., Schenectady, N.Y.
Stanley W. Parker; '13; January 6, 1981; 850 Webster St. #221, Palo Alto, Calif.
Thomas H. Callahan; '14; January 12, 1981; 41 River St. #3B, Wellesley Hills, Mass.
Donald W. Douglas; '14; February 1, 1981; 377 Camino Sur, Palm Springs, Calif.
Clive W. Lacy; '15; January 24, 1981; 261 Nahanton St., Newton Center, Mass.
Forrest C. Legard; '15; January 7, 1981; 15 Maple Grove Ave., Bath, Maine
James A. Tobey, '15; November 23, 1980; 15 Purchase St. #C-1, Rye, N.Y.
Allen L. Giles, '16; December 31, 1980; 21 Riverside Dr., Clinton, Conn.
John Gore, '16; November 15, 1980; 49 Otsego St., Canajoharie, N.Y.
Moses B. Rosenauer; '16; January 20, 1981; 60 High St., Bristol, Conn.
George R. Duryea, '17; October 23, 1979; Mountain Lake, Lake Wales, Fla.
Theodore Z. Haviland, 17; January 7, 1981; 305 West End Ave., Ridgewood, N.J.
George W. Henderson, '17; August 6, 1980; c/o Pertzoff, 2021 Hessian Rd., Charlottesville, Va.
Allyne C. Litchfield; '17; January 13, 1981; 1336 Harvard Rd., Detroit, Mich.
W. Joseph Littlefield; '17; January 31, 1981; 7901 S.W. 53rd Ave., Miami, Fla.
Harold V. Sturtevant, '18; October 17, 1980; 173 Norwood Ave., Plainfield, N.J.
George W. Woodruff, '18; January 29, 1981; 3668 Tuxedo Rd. N.W., Atlanta, Ga.
John P. Comstock, '19; January 19, 1980; 304 Milstead Rd., Newport News, Va.
S. Albert Kaufmann, '19; December 1979; 48 Bridge St., Tewksbury, Mass.
Robert C. Ellis, '20; January 17, 1981; 417A Chatham Ct., Lakewood, N.J.
Herbert K. Fairbanks, '20; December 18, 1980; St. George, Maine
Harold F. Hedberg, '20; September 22, 1980; 3333 NE 34th St., Apt. 222, Fort Lauderdale, Fla.
Morris N. Lipp, '20; December 26, 1980; 2545 Flamingo Pl., Miami Beach, Fla.
Jose G. Piza, '20; November 16, 1978; 559 Ing Ramon Gandia St., Hato Rey, Puerto Rico
Aldolph H. Aronson, '21; May 28, 1980; Security Trust, 700 Brickell Ave., Miami, Fla.
John D. Bowman, '21; February 27, 1980; 22 Penhurst Pk., Buffalo, N.Y.
Merritt F. Farren, '21; November 25, 1980; 5B Buckingham Dr., Lakewood, N.J.
Ralph F. Flather, '21; January 14, 1981; Meredith Neck, Meredith, N.H.
Howard B. Tuthill, '21; October 28, 1980; 1734 Pontiac Rd., Grand Rapids, Mich.
Herbert D. Allee, '22; December 4, 1980; 6909 9th Ave., St. Petersburgh, Fla.
Charles E. Brokaw, '22; September 10, 1980; 655 S. Clinton St. #7B, Denver, Col.
Harrison D. Folinsbee, '22; October, 1980; 269A Glen Rd., Hampton Village, Cranbury, N.J.
Warren E. Howland, '22; October 15, 1980; 610 So. 9th St., Layfayette, Ind.
Warren G. Sharples, '22; December 6, 1980; 25 Scotland Rd., Norwich, Conn.
Ward E. Shearer, '22; June 2, 1978; 131 Prospect Ave., Mount Vernon, N.Y.
Hugh M. Shirey, '22; August 29, 1980; 4 Pilgrim Circle, Rochester, N.Y.
Wilfred M. Thomson, '22; November 28, 1980; 3909 San Augustine Dr., Glendale, Calif.
Lawrence S. Vadner, '22; January 4, 1981; 126 Dartmouth Rd., Bala Cynwyd, Penn.
George E. Barnes, '23; November 17, 1979; University of North Carolina, School of Public Health, Sanitary Engineering Department, Chapel Hill, N.C.
Philip L. Coleman, '23; January 14, 1981; 6907 8th Ave. W., Brandenton, Fla.
Lucian F. Jenness, '23; May 27, 1980; 1700 West Ave S. #E4, Jackson, Mich.
Paul R. Plant, '23; November 3, 1980; Grasshopper Ln., P.O. Box 272, Lincoln Center, Mass.
Theodore J. James, '24; November 8, 1980; Avon Lake Nursing Home, 37800 French Creek Rd., Avon, Ohio.
Charles R. MacBrayne, '24; January 6, 1981; 1321 Centennial Dr., Peru, Ill.
F. Berkeley Robins, '24; December 14, 1980; 3633 Richmond St., Jacksonville, Fla.
Edward M. Sohn, '24; December 6, 1980; Box 1757, Williamson, W.Va.
Edward B. Alexander, '25; November 8, 1980; c/o

M.I.T. at Cypress Gardens. More than 200 alumni and guests—the largest U.S. gathering outside of Cambridge so far this year—came to the M.I.T. Club of Florida's festival on February 21-22. President Paul E. Gray, '54, keynoter (left), was joined by Professors Irwin W. Sizer and Norman C. Rasmussen, Ph.D. '56, as speakers, and George H. Wayne, '48, general chairman, says the festival's success assures a repeat performance in 1982. (Photo: Ricardo A. Carreras, '61)

Spring fever is beginning to arrive on the campus, a time when just gazing out of the window is a preferred activity. (Photo: Calvin Campbell)

First City National Bank, Trust Dept., P.O. Box 700, Binghamton, N.Y.
James N. Anderson, '25; January 17, 1981; 18 Longfellow Rd., Worcester, Mass.
William R. Blair, '25; November 30, 1980; 25 Main St., Topsfield, Mass.
Miles N. Clair, '25; January 23, 1981; P.O. Box 63, Cataumet, Mass.
Edwin A. Cobb, '25; December 15, 1980; 84 Triton Ave., Winthrop, Mass.
Charles E. Knight, '25; November 30, 1979; 911 Converse St., Longmeadow, Mass.
Frederick Krazler, '25; November 5, 1980; 4 Nassau Rd., Kendall Park, N.J.
Parker C. Reed, '25; January 7, 1981; 27 Hayes Ave., Lexington, Mass.
Mabel M. Rockwell, '25; June 1979.
William M. Davidson, '26; December 29, 1980; 607 Owl Way, Sarasota, Fla.
William W. Dunnell, Jr., '26; December 23, 1980; 204 Old Connecticut Path, Wayland, Mass.
Henry F. King, '26; April 2, 1980; 3333 NE 34th St., Ft. Lauderdale, Fla.
Walter D. Burger, '27; December 9, 1979; 300 N. State St., Apt. #4331, Chicago, Ill.
Warren F. Priest, '27; December 4, 1980; 79 Tunxis Village, Farmington, Conn.
Walcott S. Bissell, '28; September 10, 1979; 40 Farmstead Dr., Newington, Conn.
Nathaniel Herbits, '28; October 8, 1980; 873 N.E. 195th St., N. Miami Beach, Fla.
George N. Janes, '28; August 24, 1980; 405 E. Ridley Ave., Ridley Park, Penn.
Clifford L. Webster, '28; December 14, 1980; 312 Puritan Rd., West Palm Beach, Fla.
Edwin G. Osborne, '29; October 8, 1980; 36 Irving Ave., Atherton, Calif.
Robert Sutherland, '29; November 4, 1980; 245 104th Ave. Apt. #5, Treasure Island, Fla.
Walter H. Winchell, '29; November 6, 1980; 3 Maria Ln., Garden City, N.Y.
Emanuel I. Birnbaum, '30; November 27, 1980; 23 Woodland Rd., E-Apt. 909, Guelph Ont N1H 6K9, Canada
Raymond J. Bowley, '30; November 27, 1980; 133 Rhoda St., Fairfield, Conn.
Albert B. Deyarmond, '30; November 20, 1980; 20589 Deerfield Dr., Sonora, Calif.
Wilfred P. Eaton, '30; December 9, 1980; 802 Main St., Apt. #2-15; Toms River, N.J.
Gustav W. Klumpp, '30; December 21, 1980; 3 Beech St., Merrimack, N.H.
Dom Hillary Martin, '30; January 3, 1981; The Priory, Portsmouth, R.I.
Frank M. Baker, '31; March 5, 1980; 618 Amanda Furnace, Ashland, Ky.
Walter C. Bodycomb, Jr., '31; November 14, 1980; Box 28, Taylors Island, Md.
William O. Bruehl, '31; March 3, 1980; c/o Albert Bruehl, Bruehl Rd., Upperco, Md.
Robert M. Price, '31; November 30, 1979; 20 Harlech Dr., Wilmington, Del.
Clarence Renshaw, '32; February 2, 1980; 45 Sutton Pl. S. Apt. #3E, New York, N.Y.
Edward J. Malkin, '33; June 12, 1980; 5598 Ainsley Ct., Boynton Beach, Fla.
George W.W. Brewster, '34; February 2, 1981; Davis Cove, Cushing, Maine
John G. Gallan, Jr., '34; January 30, 1981; P.O. Box 17, 184 Ames St., Sharon, Mass.
William J. Koen, '35; January 16, 1979; 19 King St., New York, N.Y.
Charles H. Kolker, '35; 1978; Claridge House 2 Apt. #71W, Verona, N.J.
Gerald C. Rich, '35; October 28, 1980; 5638 Comanche Ct., San Jose, Calif.
Sterling A. Clark, '36; September, 1978; 403 Ridge Rd., Roxboro, N.C.
Rufus P. Isaacs, '36; January 18, 1981; 1418 Mason St., Baltimore, Md.
John S. O'Conor, '36; December 20, 1980; St. Josephs College, 54th St. and City Line Ave., Philadelphia, Penn.
Martin Garrott, '37; December 21, 1980; 100 N.E. 43rd St., Miami, Fla.
Frederick H. Merrill, '37; November 24, 1980; Haystacks, Whitegate, Northwich Cheshire England
Flora C. Stephenson, '37; February 10, 1979; 3/109 Broadway, Nedlands 6009 W. Australia
Nicholas Ferreira, '39; P.O. Box 21, Sasolburg OFS South Africa.
Thacher H. Fisk, '39; December 13, 1980; 740 Main St., Keene, N.H.
Olaf N. Rove, '39; December 27, 1980; 6 Gilliam Ln., Riverside, Conn.
James E. Barron, '42; June 11, 1980; 5749 Palm Beach Blvd., LT 117, Fort Meyers, Fla.
Joseph W. Naab, Jr., '44; December 12, 1980; P.O. Box 58, South Freeport, Maine
Samuel E. Duff II, '45; January 9, 1981; 564 Maryland Ave., Apt. #41, Pittsburgh, Penn.
Alan I. Sands, '46; June 11, 1980; 1538 West Hamson #1B, Chicago, Ill.
Louis P. Wenzell, Jr., '47; November 16, 1980; 217 Leming, Corpus Christi, Tex.
M. Alten Gilleo, '48; November 14, 1980; 3 St. Clair Rd., Morristown, N.J.
J. Herbert Brown, '51 December 27, 1980; 12 Larchmont Ln., Lexington, Mass.
John P. Rabbott, Jr., '51; October 18. 1980; 278 Monroe Dr. #6, Mountain View, Calif.
John Vernon, Jr., '51; January 24, 1981; 147 Laurel Hill Rd., Mountain Lakes, N.J.
James L. Gleason, '53; January 20, 1980; 525 Third St., Belvidere, N.J.
Burton B. Zell, '53; February 27, 1980; 101 E. Main St., Little Falls, N.J.
Malcolm E. Clark, '54; January 24, 1981; Coast Guard Academy, Civil and Naval Engineering Department, New London, Conn.
Alan Robert Glueck, '55; August 23, 1980; 86 Greenway Terr., Princeton, N.J.
Billy J. Lancaster, '61; August 12, 1980; 5322 Kelsey, Dallas, Tex.
Paul V. Garin, '65; November 19, 1978; 1836 Lake St., San Francisco, Calif.
William L. Hamilton, '66; January 10, 1981; 19704 38th Place S., Seattle, Wash.
William L. Hsu, '67; January 8, 1981; 49 Beacon St., Boston, Mass.
Kirk V. Darragh, '68; November 21, 1980; 2891 Saddle Ridge Dr., Yorktown Heights, N.Y.

Puzzle Corner
Allan J. Gottlieb, '67

From Pins to Terrapins

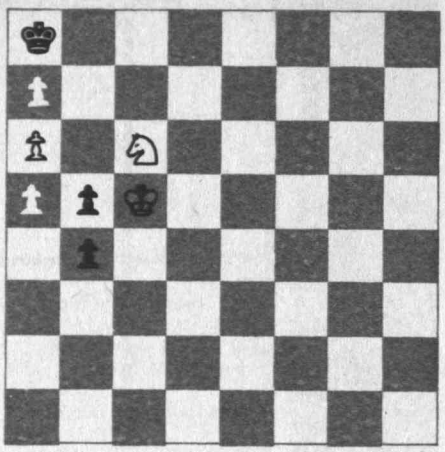
Allan J. Gottlieb, '67, is associate research professor of mathematical sciences at the Courant Institute of Mathematical Sciences of New York University; he studied mathematics at M.I.T. and Brandeis. Send problems, solutions, and comments to him at the Courant Institute, New York University, 251 Mercer St., New York, N.Y. 10021.

Let me once again answer a perennial question: What criteria are used to select solutions for publication?

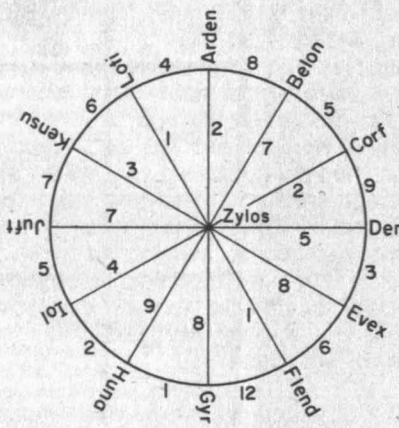
As responses arrive during the month they are simply put together in neat piles, with no record as to their date of postmark or of arrival. When it is time for me to write the column, I first weed out erroneous and illegible solutions. For difficult problems, this may be enough; the most publishable solution becomes obvious. Usually, however, many responses still remain. I next try to select for each problem a solution that supplies an appropriate amount of detail and that includes a minimal number of characters that are hard to set in type. A particularly elegant solution is, of course, preferred. I favor contributions from correspondents whose solutions have not previously appeared as well as solutions that are especially neatly written or typed, since the latter produce fewer typesetting errors.

Problems

MAY 1 We begin with a chess problem from George Farnell:
White to play and mate in two moves:



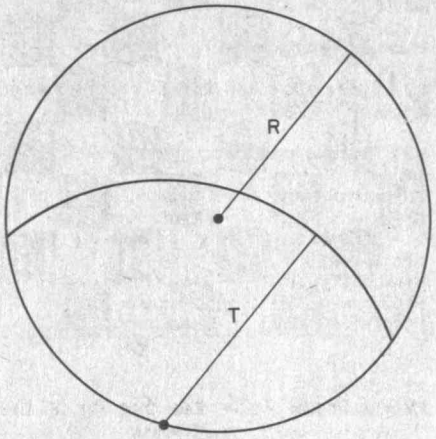
May 2 Frank Rubin has one for all the "trekkies" in the audience:
The Starship Enterprise is conducting negotiations on Arden with the Emperor of the Zylos System. Suddenly there is an alarm: a Klingon warship has entered the sector. The Enterprise must gather all of the leaders of the 12 outer planets and bring them to a conference on Zylos. It must use only the established space routes, whose travel times in zorpets are indicated in the following chart. How soon can the conference be held?



May 3 Akbar Ahmed wants to know the sum of
$1^{-1} + 2^{-2} + 3^{-3} + \ldots$

May 4 Barie Gilbert likes to construct N-by-N matrices of letters such that each row is an N-letter English word (read from left to right) and so is each column (read from top to bottom). Such a matrix is called N-perfect if the 2N words are all distinct. What is the largest N-perfect matrix you can find? Mr. Gilbert doubts that a 6-perfect matrix exists.

May 5 Frank McHargue knows a farmer who rents out one half of a circular, fenced pasture. A cow is to be tethered to a point on the fence so that she is able to graze on exactly one half of the pasture area. What is the length of the tether (T) if the radius (R) of the pasture is 100 feet?



Speed Department

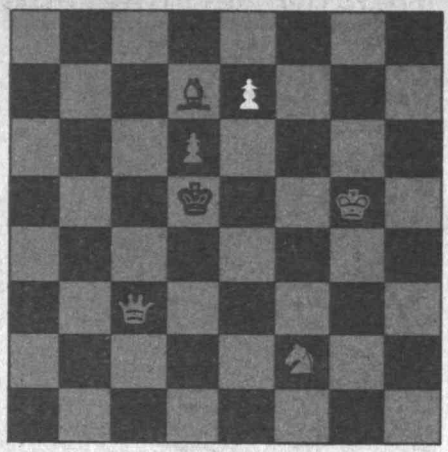
SD 1 A quick one from James Landau: In the November 1979 issue (*page A32*) you made the following incorrect statement: "But there is no time for infinite arguments in a speed problem." The great John von Neumann demonstrated the fallacy in this statement when he was asked to solve the following problem: "A train is traveling at 30 miles per hour. When it is 60 miles from the station, a bird which flies at 50 miles an hour flies from the train to the station, back to the train, back to the station again, etc. When the train reaches the station, how far has the bird flown?" Von Neumann immediately gave the correct answer. "I see you used the shortcut," his questioner said. "I was expecting you to use infinite series." "What shortcut?" asked von Neumann. "I *did* use infinite series." Question: What was the shortcut, and what was the correct answer?

SD 2 Solomon Golumb wants to know the equivalent of each of the following scientific units:

10^{12} microphones	5 holocausts
10^{12} pins	10^{6} bicycles
10^{-12} boulevards	10^{9} micrometers
10^{21} picolos	10 monologues
10 rations	2×10^{3} millinaries
10 millipedes	10^{-5} dollars
1 centipede/second	1 milli-Helen nano-nano
3⅓ tridents	

Solutions

A/S 1 (as modified in January) White to mate in two:



The new diagram published in January omitted the White knight from KB2 (it's included in the diagram above). However, many readers who had worked on the original problem, with the white King on KR_8 instead of KN_8, put the knight back in and solved the problem. The following solution is from Michael Jung:

The key move is 1: N—K4. Now if K×N then B—B6; if P×P then N—B6; if P—K3 then B—B6; and if P—K4 then Q—Q3.

Responses were also received from Matthew Fountain, Joel B. Freilich, Gerald Blum, Abraham Fineman, Peter Steven, and Elliot Roberts.

JAN 1 What is the probability of picking up a bridge hand containing no suit with exactly three cards?

The following solution is from Peter Steven:

Simply take a list of all the possible bridge hand suit distributions which do not include three-card suits (there are 25 out of 39 different possibilities); calculate the number of suit permutations for each (that's either 4, 12, or 24 depending on the number of suits of different length); multiply that by the number of combinations of cards that could fill each suit (varying from 1 for a void to 1716 for six- or seven-card suits); sum them up (there are 163.6 billion); and divide by the total number of possible hands (the combinatoric 52 items taken 13 at a time or 635 billion); and the answer is . . . .2577, or a 25.8 percent chance of picking up a hand containing no three-card suits.

Also solved by Matthew Fountain, Emmet Duffy, Harry Zaremba, Winslow Hartford, Michael Jung, and Steve Feldman.

JAN 2 Find, if possible, a set of five distinct positive integers such that the sum of each pair is a perfect square.

The only solution is from Walter Penny:

A = 7442; B = 28658; C = 148583; D = 177458; and E = 763442. A + B = 190^2; A + C = 395^2; A + D = 430^2; A + E = 878^2; B + C = 421^2; B + D = 454^2; B + E = 890^2; C + D = 571^2; C + E = 955^2; and D + E = 970^2.

JAN 3 Given a balancing scale and 15 billiard balls, of which 14 are known to be identical in weight but the fifteenth is either heavier or lighter, what is the minimum number of balancings needed to isolate the "odd" ball?

Michael Heney argues that at least four weighings are needed: using a balance-type scale, at most three pieces of information can be obtained from each weighing (either the piles are equal, the left is heavier, or the right is heavier). Thus with N weighings, at most 3^N states can be distinguished. So to determine which of the possible states occurred, N must be at least 4.

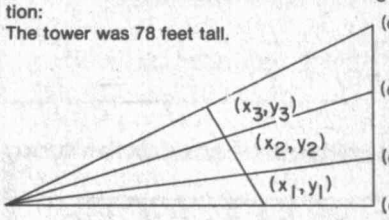
Emmet Duffy sent us a four-weighing method: Place seven balls on each side of the scale. If the scale balances, the odd ball (not on the scale) is heavier or lighter. Test it against a known good ball to find out if it is heavy or light. Total of two balancings. If one side of the scale goes down, mark all balls on that side H for heavy and mark all on the other side L for light. Put three H balls and three L balls on each side of the scale with an H and an L off the scale. If the scale balances, the odd ball is the H or the L off the scale. Test either one against a known good ball. If it doesn't balance, it is the odd one; and if it does balance the odd ball is the other one. This takes three balancings. If the scale does not balance with six balls on each side, then the odd ball is one of three H that went down or one of the three L that went up. Take these six and place an H and an L on each side and an H and an L off scale. If the scale balances the odd ball is the H or L off scale; and if the scale does not balance the odd ball is the H that went down or the L that went up. In either case, make the same test as before to determine which of the pair is odd. This takes four balancings.

Also solved by Joel Freilich, Steve Feldman, Winslow Hartford, Michael Jung, Peter Steven, Matthew Fountain, Marion Weiss, and Richard Kruger.

JAN 4 One good way to estimate the height of an object is to take a known height, sight along a ruler until the known object subtends an easy length to work with, and then take the proportional height subtended by the unknown object. Recently Frank Rubin attempted to measure the height of a bridge in this way. He had a friend who was exactly six feet tall stand next to the bridge tower. He held the ruler so that his friend appeared to be one inch tall; the height of the roadway then appeared to be four inches and that of the supporting tower ten inches. Hence Frank estimated that the roadway was 24 feet above the ground and that the tower was 60 feet high. Later Frank found that the roadway was actually 26 feet above the ground; clearly his error was because he did not hold the ruler precisely vertical. What, then, was the correct height of the tower?

Matthew Fountain sent us the following solution:

The tower was 78 feet tall.



Let the eye be at the origin (0,0) and the top of the bridge tower be at point (a,t). Then (x_1,y_1), (x_2, y_2), and (x_3,y_3) are the 1″, 4″, and 10″ points on the ruler in line with (a,6), (a,26), and (a,t), respectively.

$y_1 = y_3/4$, $y_3 = 10y_3/4$, $x_1 = ay_1/6 = ay_2/24$, $x_2 = ay_2/26$, $x_3 = x_2 + 6(x_3 - x_1)/3 = 3ay_2/26 - 2ay_2/24 = 5ay_2/156$, and $t = ay_2/x_3 = (10ay_3/4)/(5ay_2/156) = 78$.

Also solved by Michael Jung, Emmet Duffy, Winslow Hartford, Harry Zaremba, Richard Kruger, and Peter Steven.

JAN 5 How many people must be present to give a 50-percent probability of having two coincident birthdays in one year? (Most people are surprised to find that only 23 are needed.) But what is the minimum number of people to give at least a 50-percent probability that there would be three coincident birthdays in the year?

The following solution is from Frank Carbin:

The method of attack is to compute $1 - P_1 - P_2$, where

P_1 = Prob (no shared birthday given N people); and

P_2 = Prob (1 or 2 or . . . n/2) dates with exactly two people having that birthdate, given N people.

The enumerations are done via the expansion of $(x_1 + \ldots + x_{365})^N$

The no-shared-birthday case corresponds to the terms

$$\frac{N!}{(1!)^N}\, x_{i_1} \ldots x_{i_N},$$

of which there are $\binom{365}{N}$ giving a probability of

$$\frac{N!\binom{365}{N}}{365^N}$$

The one-date-has-two-people case corresponds to the terms

$$\frac{N!}{2!\,(1!)^{N-2}}\,x_{11^2}\cdot x_{11}\cdot\ldots\cdot x_{1N-2},$$

of which there are $\binom{365}{1}\binom{365}{N-2}$,

giving a probability of

$$\frac{\frac{N!}{2!}\binom{365}{1}\binom{364}{N-2}}{365^N}.$$

More generally, the K-dates-have-two-people case corresponds to the terms

$$\frac{N!}{(2!)^K\,(1!)^{N-2K}}\,x_{11^2}\cdot\ldots\cdot x_{2K^2}\cdot x_{11}\cdot\ldots\cdot x_{2N-2K},$$

giving a probability of

$$\frac{\frac{N!}{2^K}\binom{365}{K}\binom{365-K}{N-2K}}{365^N}.$$

Thus, the probability that at least three people share a birthday given N people is

$$1-\frac{N!}{365^N}\sum_{L=0}^{N/2}1/2^L\binom{365}{L}\binom{365-L}{N-2L}.$$

For N=87 (resp. 88), the probability is .49945 (resp. 51107). Thus, 88 people are required for a 50-percent likelihood.

Also solved by Floyd Klavetter, Winslow Hartford, Matthew Fountain, Emmet Duffy, Harry Zaremba, and the proposer, Ernest Steele.

Better Late Than Never

1980 M/A 3 The proposer submitted a solution for eight contestants and 50-50 probability, a copy of which is available from the editor on request.

A/S 2 Frank Rubin notes that, since the problem did not specify *positive* integers, improved answers are possible. For K=2, {0,2,3}; for K=3, {−9,3,9,11,17}; and for K=4, {−9,1,3,7,12}. Mr. Rubin adds that he has formed a puzzle contest company, and contest entries are available from him at 59 DeGarmo Hills Road, Wappingers Falls, N.Y. 12590 (include a self-addressed stamped envelope).

OCT 2 Michael Jung has responded.
N/D 1 Robert Bart has responded.
N/D 2, 3 Robert Bart and Matthew Fountain have responded.
N/D 4 Robert Bart, L. Upton, and Matthew Fountain have responded.
N/D 5 Robert Bart and Matthew Fountain have responded.

Proposers' Solutions to Speed Problems

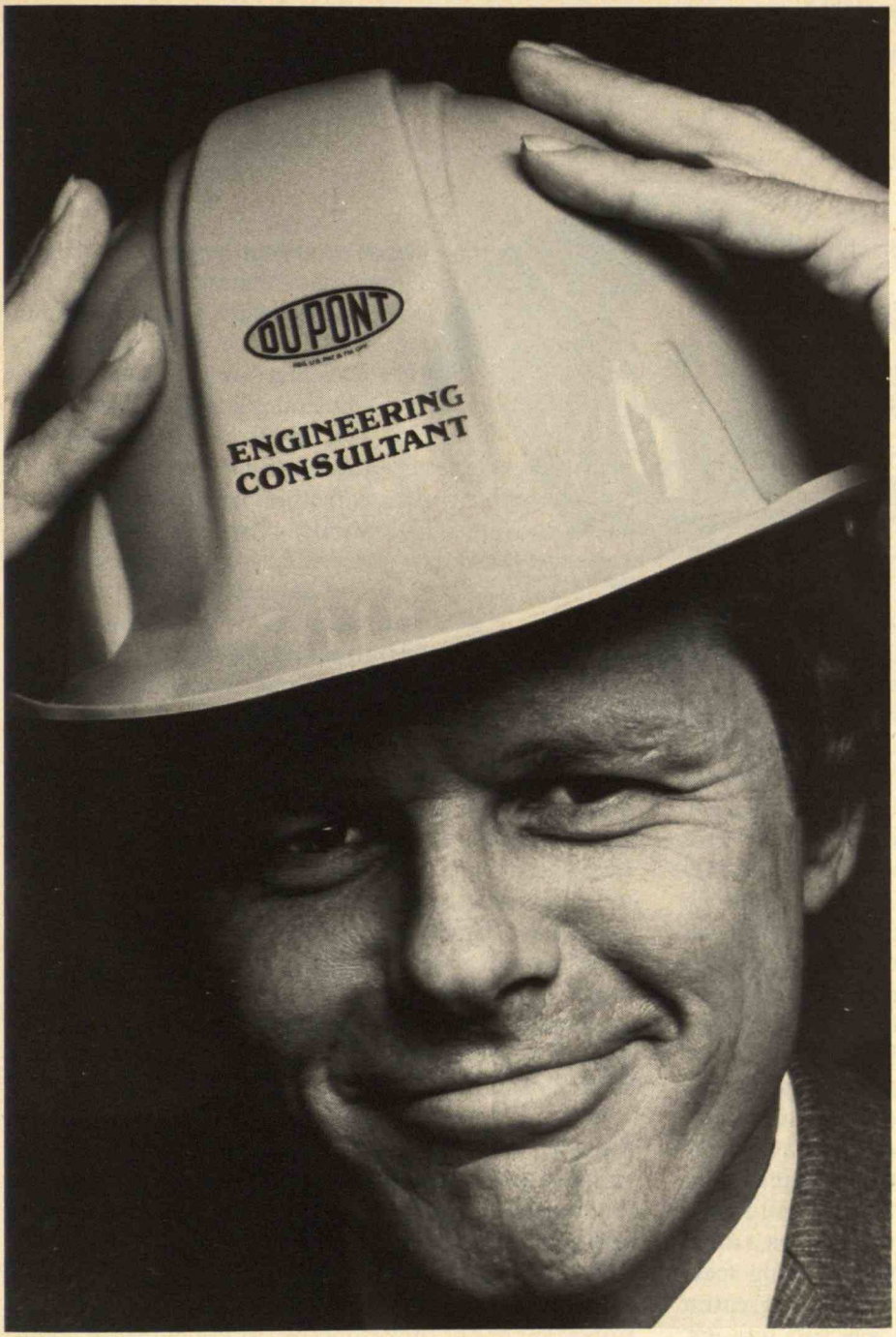
SD 1 The train takes two hours to reach the station. In those two hours the bird flies 100 miles.

SD 2 The following is the conversion table for scientific units:

10^{12} microphones	= 1 megaphone
10^{12} pins	= 1 terrapin
10^{-12} boulevards	= 1 pico-boulevard
10^{21} picolos	= 1 gigolo
10 rations	= 1 decoration
10 millipedes	= 1 centipede
1 centipede/second	= 1 velocipede
3⅓ tridents	= 1 decadent
5 holocausts	= 1 Pentecost
10^8 bicycles	= 2 megacycles
10^9 micrometers	= 1 kilometer
	= 200 pentameters
10 monologues	= 5 dialogues
	= 1 decalogue
2×10^8 millinaries	= 4 seminaries[1]
	= 1 binary
10^{-5} dollars	= 1 Millicent
1 milli-Helen	= the amount of beauty required to launch 1 ship.
nano-nano	= a prefix designating 10^{-18}

[1]The enlightenment generated by a *seminary* is measured in *luminaries*.

Put on a new career



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The explaining of illness was the most important and time-consuming part of what was then called "the art of medicine."

task was the most important and time-consuming part of what was then called "the art of medicine," and it still is. Indeed, this has been the central duty of medicine, justifying the profession's existence all the way back to its origins in shamanism. When you think about it, the first thing sick people want to know, and the sicker they are the more urgently they want to know it, is: What's gone wrong and what happens next? Am I going to live? The quality of medicine's answers to these questions and, therefore, the very usefulness of the doctor were always matters of doubt until the great medical reforms of the nineteenth century. And by the time of Osler and in the decades that followed, science became the basis for explanation and the answers became correspondingly more reliable.

It is easy to see why the mere act of explaining was important, given the nature of illness before the discovery of antibiotics and the near-successful conquest of infectious disease. Living was a considerably more chancey enterprise then. If you developed typhoid fever, still common in the early years of my father's practice, you knew you were in for two months of high fever, deep malaise, and debilitation, with the constant potentially lethal risk of hemorrhage or perforation of the intestine. If it was lobar pneumonia, the most common serious infection when I was a medical student, you had the prospect of recovering spectacularly or dying within two weeks. The greatest danger of all, feared by everyone, was tuberculosis. People worried then about TB as they worry now about cancer, but for better reasons. People of all ages died from tuberculosis and there was nothing at all to be done about it. Rheumatic fever, the cause of rheumatic heart disease, was the first thing to worry about whenever a young child developed a sore throat, and if you didn't worry about this, you had to worry about poliomyelitis. The chief cause of insanity, filling the state hospitals of the time, was syphilis of the brain. It was an enormous relief to be told that you or a member of your family was not suffering from one of these things, and this was the doctor's principal function.

When I was an intern at the Boston City Hospital, swept off my feet by the new demands for science in treating infectious disease, I used to wonder what my father did to keep so busy in his practice back in the days when there were no sulfonamides or penicillin and no way of treating anything. Throughout my childhood, our telephone rang day and night, and I remember waking up often to the sound of my father heaving out of bed and off in the family car on house calls carrying along his black bag, which contained almost nothing of any real value. There was nothing exceptional about his practice; this is what life was like for all the doctors in town because there was very little any of them could do. He was, by the way, fully aware of this, as were his colleagues. He used to complain to me sometimes that most of the time he felt helpless. He was never convinced that anything he did made a real difference, but his patients felt differently. A good many were solidly convinced that their lives had been saved by my father's presence. There is a mystery here, an aspect of medicine forgotten by too many people, doctors and patients alike.

Once the nature of the illness has been identified and conveyed to the patient, several other things have to happen. First of all, doctors take responsibility for the outcome, for better or worse, and, perhaps most important of all, they stand by. In the old days, standing by was what doctors did. They might not have much in that black bag, but their presence made a difference.

Forty years ago, just before the profession underwent transformation from an art to science and technology, it was taken for granted that the medicine we were being taught was precisely the medicine that would be with us for most of our lives. If anyone had tried to tell us that the power to control bacterial infections was just around the corner, that open-heart

It was taken for granted
that the medicine we were being taught in 1937 would
be with us for most of our lives.

surgery or kidney transplants would be possible within a couple of decades, that some kinds of cancer could be cured by chemotherapy, and that we would soon be within reach of a comprehensive, biochemical explanation for genetics and genetically determined diseases, we would have reacted in blank disbelief. We had no reason to believe that medicine would ever change. We knew that subacute bacterial endocarditis and tuberculous meningitis were always fatal, and we regarded schizophrenia as a totally insoluble problem. We believed that senile dementia was an act of nature for which we would never have an explanation, much less a treatment.

Now all of this has begun to change. Tuberculosis has vanished as a threat to the life of young children, and there are so many new clues to the etiology of schizophrenia that it has become difficult to choose among them. Similarly, senile dementia is now recognized as one of the great challenges to medical science.

So Much to Learn

What this recollection suggests is that we should keep our minds wide open to the future. Because change is inevitable, we should make sure that the changes are made in the right direction. This means, from my point of view, which I acknowledge to be self-interested and wholly prejudiced, more science. We cannot go back to the old days in medicine, although we ought never to forget the healing property of a physician's presence. We are beset with the imperfections in our profession, we do a lot of things the wrong way, yet there is no prospect for changing medicine for the better in the years ahead except through more and profounder science.

When people in my position say things like this, we are well advised to add a cautionary footnote or two. We are always at risk of sounding like we are making too many promises and speaking out of hubris. We are not about to change the world, nor are we in possession of scientific understanding so powerful as to frighten people with what we might do next. We are, I would say, *pretty* good at using science in medicine, but only pretty good. Biology is booming along, with cascades of new information pouring in from laboratories around the world. However, biologists have not yet reached the point where they can sit down and deal with great paradoxes like their colleagues in physics. Nor can they yet attempt the construction of great unifying theories because they do not possess enough information; biology is still perhaps a pre-Newtonian endeavor. And medicine seems to bob along in the wake of biological science, as well as physics and chemistry, capitalizing on whatever bits of information look useful but always trailing behind. Modern medicine lives off the fundamental sciences, and thus the greatest of all anxieties, at least for the immensely expensive health-care system, involves the continuing flow of information from the basic sciences.

A friend of mine, a biomedical scientist responsible for the future of one of the country's major research institutions, recently sent me a set of questions about the application of biological science to medical problems. Heading the list was the most difficult and embarrassing question: What are some examples of the usefulness of the biological revolution, beginning with the discovery of the double-helical structure of DNA and culminating in today's insights into gene structure, function, and intervening sequences, recombinant DNA and all? Anticipating my answer, my friend posed his second question: Must we assume that medicine will always lag a half-century behind the rest of biological science, capable of useful applications only when the final details of disease-causing mechanisms have been revealed by cellular biology? How can this process be speeded up?

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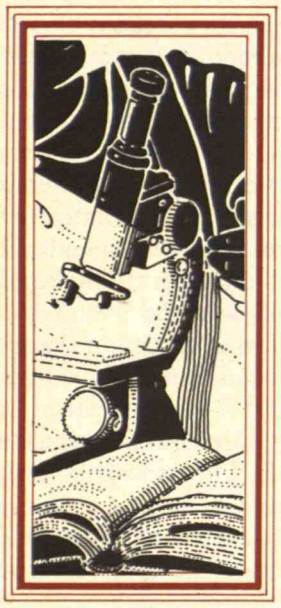
only pretty good.

Questions like these are being raised more urgently than ever before, partly out of sheer impatience with what is perceived to be the slow pace of medicine in treating or preventing today's major health problems, partly because medicine costs so much more each year, and partly, perhaps *chiefly*, because the major justification for the spectacular national investment in basic research over the past 30 years has been the implicit promise that health problems can ultimately and perhaps only be solved scientifically. But here we are 30 years down the line and cancer, heart disease, mental retardation, stroke, schizophrenia, arthritis, and multiple sclerosis are still with us, and more of us in our declining years are being incapacitated and our families ruined by dementia. Could it be that we are on the wrong track, that science is the wrong way to go, that diseases like cancer and dementia are part of the human condition, and that we should be doing something else?



These questions are being asked publicly, and I have never known a time of such quick and ready answers. We become ill, it is said, because of the environment we've created or failures in our lifestyle or lack of exercise or being out of touch with our bodies or—and this is the most fashionable of all—thinking wrong. Ivan Illich says that we become ill because of doctors. A new discipline called holistic health care—*health care*, mind you, not medicine—seems to mean, when you examine it carefully, giving up science and technology altogether.

There is a serious underlying question here, penetrating the noise. How can we have learned many rich details about the inner workings of all sorts of cells and still be stuck with the unfathomability of cancer? How is it that the people doing biological science are so bright and productive and the medical people so dumb? It sounds as though medical science is in trouble, but I doubt it. I would expect any enterprise of such importance, costing billions of public dollars, to become of engrossing public interest, and I cannot imagine this happening without engendering considerable public criticism from all quarters, including the scientific community itself.

Part of the concern stems from the fact that real scientific progress with applications of great value to society *have* been made, and we quickly take such advances for granted. Yet for all the apprehension about the uncontrolled pace of science, never before have the expectations and the impatience for new benefits from science been so high.

Investigators unraveling the mechanisms of unexplained diseases seem more optimistic about the prospects for their respective fields than in any previous time, but it is interesting that each is skeptical about the chances of the others. The immunological people feel that they are beginning to get quite close to the center of things, but they doubt that their colleagues in neurobiology or cardiology or diabetes are getting anywhere. The virologists, molecular geneticists, and cell biologists each believe that they will have the crucial answers before anyone else. The overall atmosphere is one of great excitement and anticipation. New information swamps us in journals, reprints, preprints, manuscript drafts, and long-distance telephone calls. There are groups of young researchers in laboratories in New York, Dallas, Pasadena, and Paris, working with colleagues in New York, Melbourne, London, and Tokyo, as intimately as though in the same corridor of the same building.

Some of the new information for which we used to rely on journals seems to be getting around by a mechanism I can only call gossip. This change stems from the realization that there is still so much to be learned and so many good, answerable questions to be raised that there can never be enough researchers. Everyone is becoming conscious of this and it makes the atmosphere lighter in spite of the shortage of funds.

Back to Basics

I think I should add here that the study of disease mechanisms is a proper one for basic science, more

There is no prospect
for changing medicine for the better except through
more and profounder science.

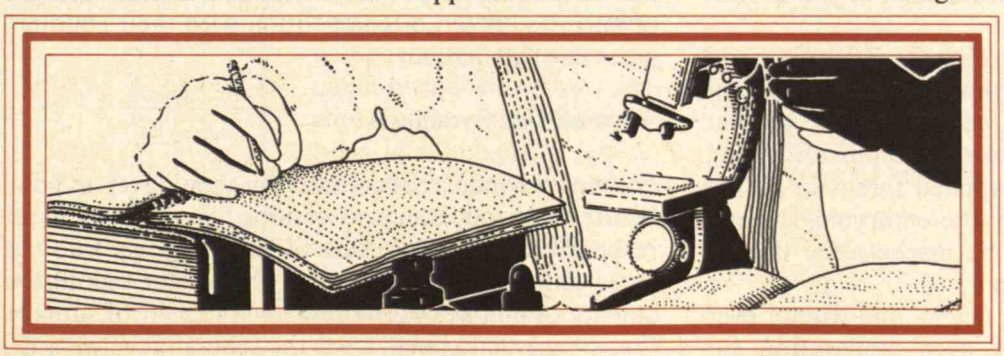
promising for the next two centuries than ever before in the history of medicine. We sometimes call this clinical science, sometimes experimental pathology, but whatever it is called, it is basic research and filled with difficult biological puzzles. There is widespread misapprehension about this, especially among biological scientists, who sometimes tend to regard the study of disease as a form of applied research. I know of no more difficult problem in biology than discovering the underlying mechanism of the senile dementias, and I expect problems like this to be solved sooner or later by fundamental research.

I am entirely optimistic about the future prospects in biological medical science. Immense advances have been made in just the last three decades in our understanding of how normal cells work, how tissues develop and become organized, how cells communicate by chemical signals, how organisms defend themselves against foreign invaders, and even in brief glimpses of how the brain works. I do not believe there are any impenetrable barriers to obtaining a deep understanding of disease processes, and I see no reason why we should not ultimately gain reasonable control over human disease in general. This has nothing to do with mortality. We will still die on schedule, but we can spare ourselves the incapacitating and painful ailments that now make aging itself a sort of disease, provided we continue the kinds of basic research now well launched and pick up new lines whenever they present themselves.

However, I confess to being somewhat pessimistic about the current prospects for *doing* basic research, especially on disease mechanisms. My anxiety stems from the fear that one cardinal requirement of basic science that differentiates it from applied science and

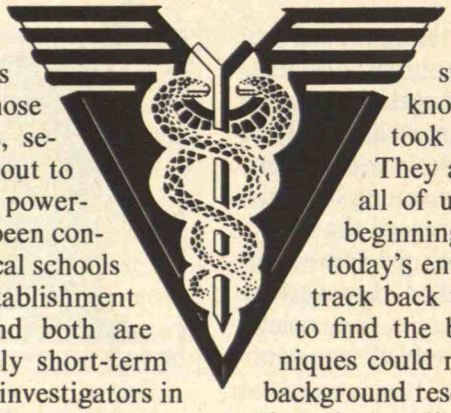
development is being overlooked in our national support of science: the absence of time constraints. Basic research cannot be done on a schedule, laid out and programmed in advance as though building a bridge, making a proximity fuse, or visiting a planet. The work is always a sort of gamble, with the most important and useful results emerging from very long shots. It is very hard to program the work far in advance and in fine detail when what you are looking for is really an astonishment.

The present drift of affairs in research ought to be a source of worry for the whole scientific community. Science has recently become more of a short-order enterprise than a long-term investment. More and more of today's research is done piece by piece in response to specific demands, with hopes for quick and usable results, and if we keep on this way, the country risks a gradual systematic reduction in the scale and quality of genuinely basic science. The trouble arises partly from the successes already achieved and the expectation that more should follow, quickly and predictably. What is not generally realized is that most of today's promising medical advances—the treatment of hypertension and Hodgkin's disease, cardiac surgery, and the newly discovered regulatory hormones in the brain—are the results of fundamental research begun 20 or 30 years ago by investigators who had something else on their minds at the time. We are drawing capital from a bank of undifferentiated information stored long ago, and that bank is in constant need of replenishment.



The underlying motivation in basic science is the insatiable curiosity of an individual investigator about a mechanism in na-

Never before have the expectations and the impatience for new benefits from science been so high.



ture. It does not start with a hankering for a product, although it is safe to say that all scientists, even those working on the most arcane topics, secretly hope that their work will turn out to be useful. Today's quandary is that a powerful apparatus for doing research has been constructed in the universities and medical schools and another immense scientific establishment has been built within industry, and both are investing their resources in relatively short-term projects. The youngest and brightest investigators in the universities, competing for federal grants that are less abundant in real dollars than ten years ago, are more cautious than ever in designing their experiments. There is a drift toward "safe and sound" projects and less inclination to gamble on risky ideas. The laboratories run by the corporate world are becoming even more conservative, shying away from projects that do not promise a salable product and more fearful than ever of intervention by regulatory agencies.

Today's Long Shot, Tomorrow's Bonanza

It seems only yesterday that cell biology was the purest and most basic of all fields in biomedical research, in constant need of defense before skeptical congressional subcommittees, difficult to justify except on grounds of rather vague prospects for future usefulness. Now, almost overnight, it looks like a way to make lots of money. The big pharmaceutical houses are already doing cell biology in great vats, while tiny new corporations are sprouting at the edges of many university towns for the development of innovative and patentable technologies. Cells are not just useful, they are about to yield profits.

So it seems that basic research has suddenly turned into applied science, and from here on we might expect quick profits. Maybe we should give up that loaded term "basic," and concentrate our efforts on doing the same wonderfully applied things in all the other fields of biology. Surely the embryologists and neurobiologists could enter the marketplace if they would only put their minds to it.

Of course, it is regrettably not so, and cannot ever be so. Although it is pleasant, even exhilarating, for biologists to contemplate their heady success with recombinant DNA, they know better than anyone how long it took to reach the stage of applicability. They also know, and should be reminding all of us, that these applications had their beginnings in work so far removed from today's enterprises that it is already difficult to track back through the network of experiments to find the beginnings. Recombinant DNA techniques could not have evolved without 30 years of background research in virology and molecular genetics, almost all done without the faintest inkling of anything like recombinant DNA.

It is necessary to say these things lest the people in charge of the country's science policy become more convinced than they already seem to be that useful and usable science can be ordered at whim. The study groups of the National Institutes of Health and other review bodies have become much more conservative and tend to make awards only for projects that seem safe and sound. The sort of gambling on imaginative ideas that carry a high probability of *not* turning out as predicted is no longer the driving force in the scientific enterprise. No one at either end—in the community of working scientists or in the bureaucracies governing the support of science—is willing to run the risk of being wrong. If this continues, the country's basic science effort will come to a standstill.

The recent examples of marketable products from such things as recombinant DNA ought to be raising new anxieties in the segment of society with the greatest economic stake in basic science: corporate America. For if long-term investments in basic science are not continued, corporations will find themselves out of business, or out of competition with their counterparts in other nations.

An Amicable Symbiosis

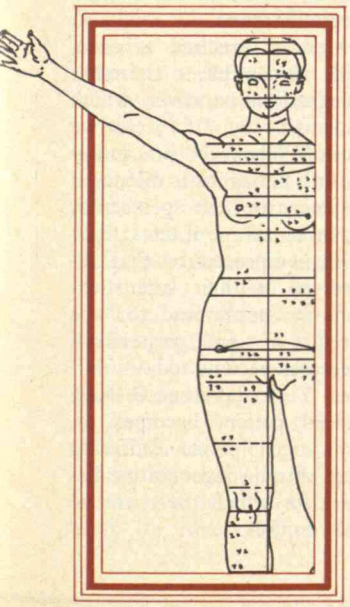
Perhaps the industrial community should step in now, before it is too late, and assume its share of fiscal responsibility for the future of basic science. I do not mean philanthropy or noblesse oblige, nor should the amount of money be anything like the scale of support for science that comes from the federal government.

There is a drift toward "safe and sound" projects and less inclination to gamble on risky ideas.

Some novel mechanism for partnership should be worked out between the corporate and the academic world, specifically designed for the very long term. Vast sums of money will be required to provide the incentive to mount truly long-range research projects, which the private universities and research institutes will need for their survival over the next quarter-century, and on which industry will then depend for its livelihood. The stakes are high, but so is the potential payoff.

There are already a number of models for this kind of industrial-academic linkage, but there ought to be a great many more. The physical scientists and the chemists have been a lot brighter and more imaginative about this than the biomedical community. Bell Labs, for example, long ago built a research institution in which basic and applied science are elegantly coupled, with a continuing flow of enthusiastic consultants moving in and out of the university world. Monsanto has entered into a long-term contractual partnership with laboratories at Harvard Medical School, M.I.T., and Caltech, and a few other universities have arrangements to provide industry with early access to the results of fundamental research.

It should be possible for certain industries such as the pharmaceutical industry to become formally coupled to whole university departments, or even whole research institutes, with faculty appointments for selected members of an industry and opportunities for graduate students and post-doctoral fellows to train in industrial laboratories. There are also occasions, which I believe will become much more frequent over the next two decades, when basic observations in a university laboratory might open up whole new approaches to the treatment or diagnosis of a particular disease, but that new approach would be perceived more quickly and precisely by an industrial science group than by the academic scientists. We need better ways of bringing these separate communities together so that they talk to each other out of purely intellectual interest, holding joint seminars and sharing in the training of young investigators.

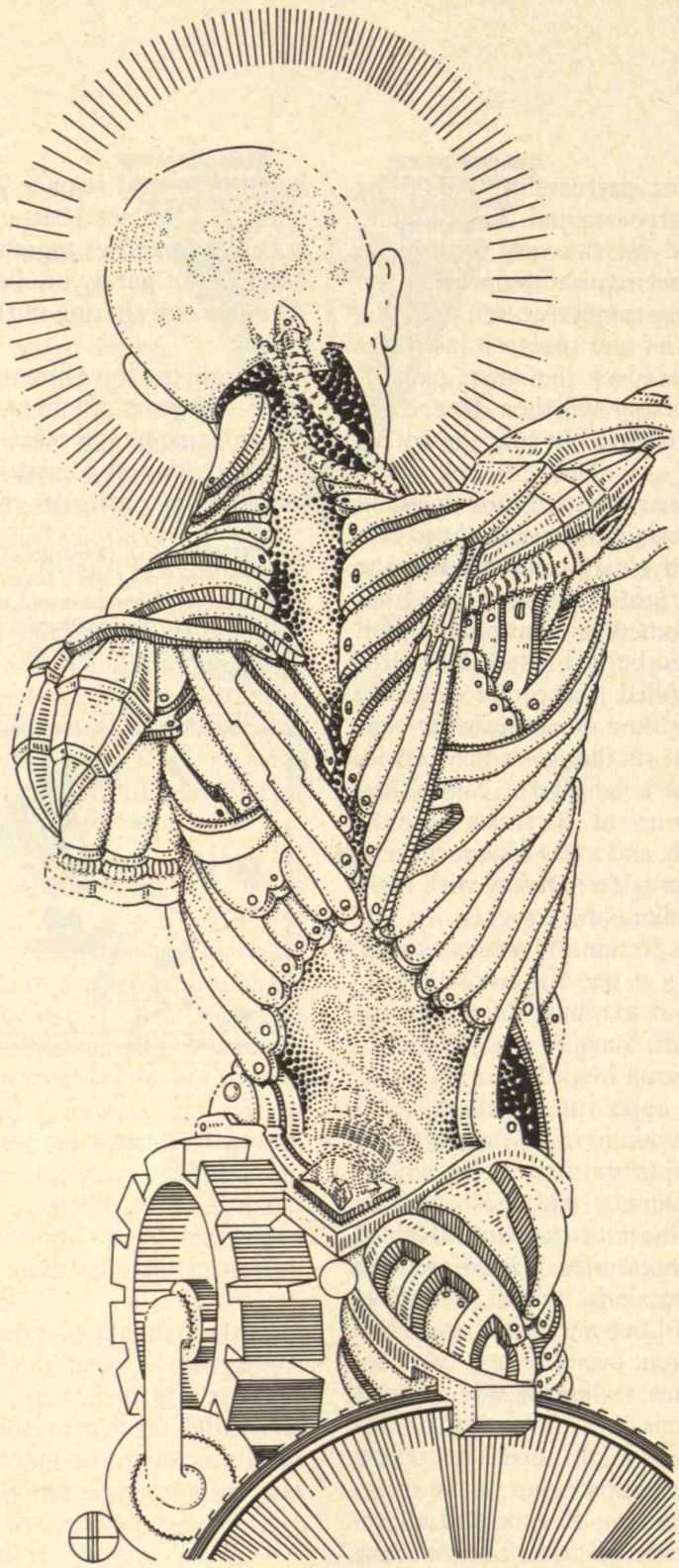


I urge the investment of stable funds in long-term—20 years or longer—support of basic science in the universities and research institutes. At stake is the productivity and competitive edge of this country as much as any particular medical advance.

Lewis Thomas, M.D., chancellor of the Memorial Sloan-Kettering Cancer Center in New York City, is author of two collections of essays, *The Lives of a Cell* and *The Medusa and the Snail.* This article is based on Dr. Thomas's essay, "Future Prospects for Basic Science in Medicine," from the October 1980 issue of the *Bulletin* of the American Academy of Arts and Sciences.

Pulling the Plug: Reevaluating the Medical Enterprise

by Dee B. Crouch and Lawson Crowe



It is said that a physician's duty is to ease suffering and prolong life. We assume that doctors must help people by directly interfering in the disease process, employing whatever biomedical technologies are available. Yet life-prolonging efforts have not always been the object of medical practice. In the Hippocratic tradition, physicians were taught to refuse to treat "those who were overmastered by their diseases"; that is, they were not obligated to treat the mortally ill.

In a recent critique of Western medicine, Tom Boyce and Max Michael wrote, "Regardless of the natural history of the disease or the cost of its control, the elimination of all disease remains a focus of our efforts in health care." Physicians are instructed to "focus on destructive aspects of the pathological process, but they fail to understand the full functional characteristics of the disease"—that disease has beneficial aspects for both the species and the individual. Protection from malaria by the sickle-cell trait in Africa and the Mediterranean basin is cited as an example of a disease that enhances species survival. Nevertheless, the hope for a "disease-free life," the implicit goal of scientific and medical knowledge, prevails.

According to the Western view, "disease" means faults, lesions, or imbalances in an organism, which is viewed as a collection of parts adapted to one another. If the human organism is essentially a "machine," then if one knows what is wrong with one or more of the "parts," one will know how to "treat" it.

In sharp contrast to this mechanistic view, ancient Greek medicine was highly speculative. The prevailing theory reduced the human body to blood, yellow bile, black bile, and phlegm. These four humors were balanced in healthy bodies, while imbalance resulted in disease. The physician assisted nature by restoring this balance.

Early in the fifth century B.C. began an increased emphasis on clinical observation; examination of the patient became the physician's most important tool. This empirical orientation survives as the basis for medical practice today. Physicians are taught the importance of facts; the more "data" that can be obtained about a patient, the better. This approach virtually guarantees the success of a new instrument or procedure that generates more data about the patient. For years standard hospital admission policy has included a battery of blood tests and x-rays regardless of whether such data are directly linked to a patient's problem. Moreover, this passion for facts has often led beyond the patient to the healthy person. Mandatory premarital blood tests and the annual physical examination are two common examples. Such practices have recently come under criticism, especially when it has been shown that they have little predictive value.

Medical practice is especially susceptible to the technological imperative, which leads us to say, "If we can, we must." Whenever practitioners face a diagnostic dilemma, they turn to their spectacular armamentarium of tests, therapies, and procedures that, regardless of their sophistication, inevitably lead to "the paradox of time": yesterday's successes become today's failures. Yesterday's successfully treated patient becomes today's aged person suffering from chronic degenerative diseases for which there are no known cures.

From Artisan to Technician

Before World War II, medicine was not regarded as a science. Indeed, doctors had little use for abstract theories; they regarded themselves as practitioners of an "art." But during the 1940s and 1950s, the use of sulfa drugs and penicillin created a revolution in the treatment of certain infectious diseases, and the physician's business was dramatically transformed. Infectious diseases that had frequently confined patients to bed for 4 weeks were subdued in 72 hours. This extraordinary change in therapeutic technology relieved physicians' suspicions of theory and prepared them for the advent of biomedical science.

Although the medical profession has established itself as a primary source of health care in this country, various studies show that most patients have self-limiting diseases not requiring a physician's attention. Some of today's most common disorders such as insomnia, headaches, and the common cold are generally cured by self-administration of medicine. This readiness to identify various human conditions as medical problems has led to the progressive medicalization of American society. In the nineteenth century, the drunk was considered morally weak, a sinner. Today, the alcoholic is regarded as suffering from a peculiarly coercive, self-induced disease. We tend to treat as disease everything from child abuse to drug abuse to overeating to compulsive gambling.

Mind Over Body

One of the chief duties of physicians has traditionally been to relieve patients of responsibility for illness. Once they have accepted the role of sick person, patients are at liberty to avoid normal social responsibilities. But what is the person's responsibility before becoming ill? Many have argued that people should assume responsibility for their own health through significant changes in lifestyles and values. This would require that patients be viewed not merely as the subjects of medicine but as autonomous human beings participating in the management of their own health.

Many writers have commented on the impersonal, objective view of a diseased body by physicians and nurses. Some believe that the demands of medicine as a "science" promote a tacit agreement between patient and physician that encourages this artificial view. We believe that the preservation of personal autonomy should be a major objective of medical practice and agree with those who decry the tendency of many patients to surrender responsibility for their health to physicians and others in the health-care system. Healing is enhanced when the whole person, as defined by the possession of rational freedom or autonomy, is restored.

There is now strong evidence that general reductions in morbidity and mortality rates during the last 200 years are linked to social, political, and economic factors rather than advances in medical science. Despite this fact, physicians continue to practice as if medical problems had only medical solutions. Although there have been some notable exceptions, the medical profession has generally not pressed for societal action to prevent disease and death.

For example, people concerned about personal choice object to mandatory passive restraint systems in cars, as do some profit-conscious automobile manufacturers. In general, the medical community has not participated in the design and implementation of restraint systems, which would greatly reduce the need for emergency medical services. The best modern medicine has been able to offer is intensive-care units, blood banks, and chest surgeons—an expensive and inadequate response.

It is time to reevaluate the practices that led us to spend 9 percent of the gross national product—$240 billon—on health care in 1980, and to reconsider the role of the physician, the expectations of the patient, and the responsibilities of the society for the maintenance of health. We do not suggest that science stop seeking new knowledge and technologies to ameliorate suffering and preserve human dignity. Rather, we believe that the present approach to health care is largely a problem of misplaced values and, therefore, misplaced responsibilities and goals.

Biomedical research and improved technologies may help reduce the period of morbidity before death, but death will come whether or not we have disease. Individuals have a moral obligation to contribute to the ordering of a society that places the highest value on their health and freedom of choice, and that finds a balance between the health and welfare of its members and the mindless, wasteful exploitation of the world around it.

With such recognition of values and responsibilities, physicians could once more become "professional advisors and counselors," practitioners of an art, making use of all appropriate biomedical science and technology. Their commitment would not be to some abstract ideal of "eternal health" or "disease-free life" but to treating the patient as an autonomous person. Such a view would reduce employment of expensive and useless life-extending technologies for the aged, the terminally ill, and those who have suffered irreversible and ultimately fatal traumas, and would encourage patients to accept the inevitable limitations of the human condition. □

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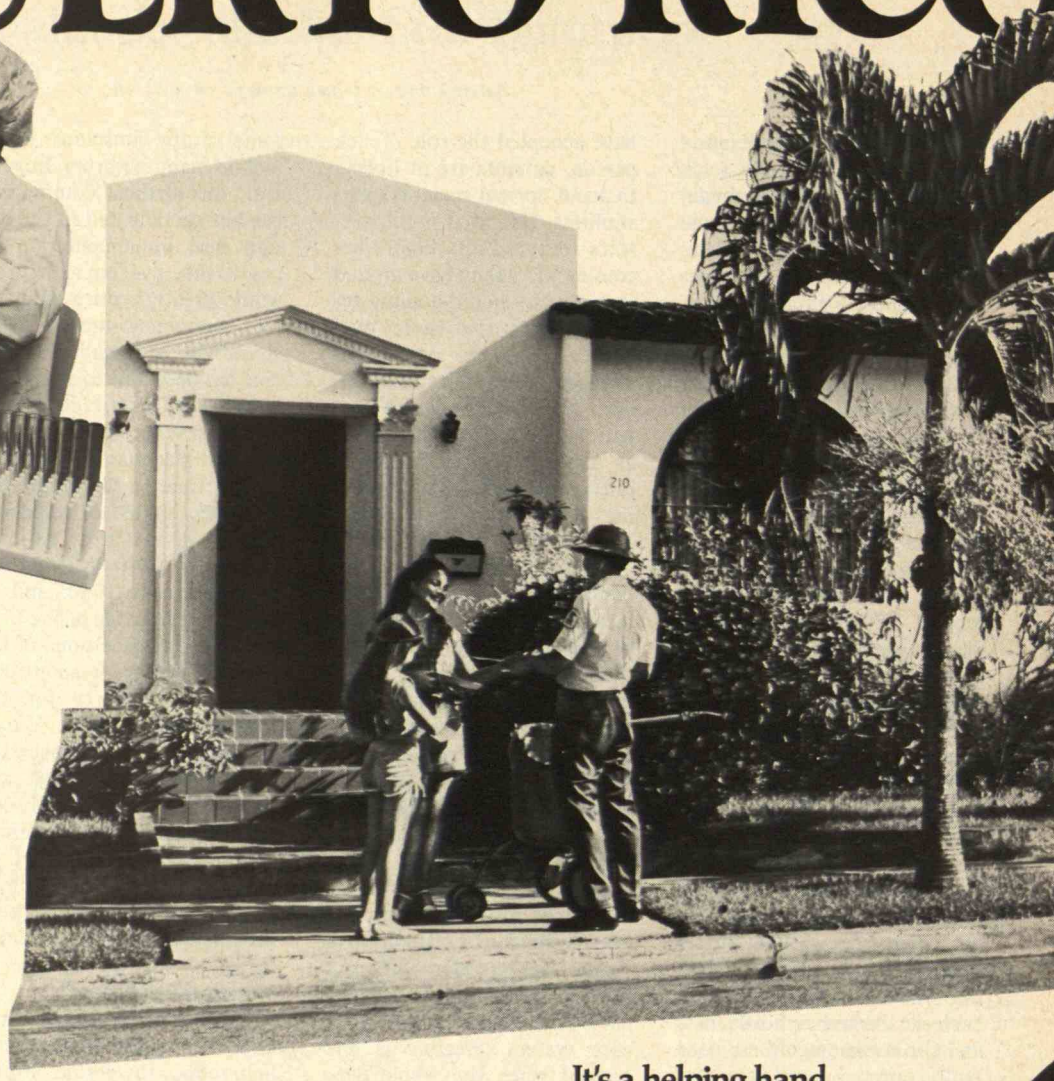

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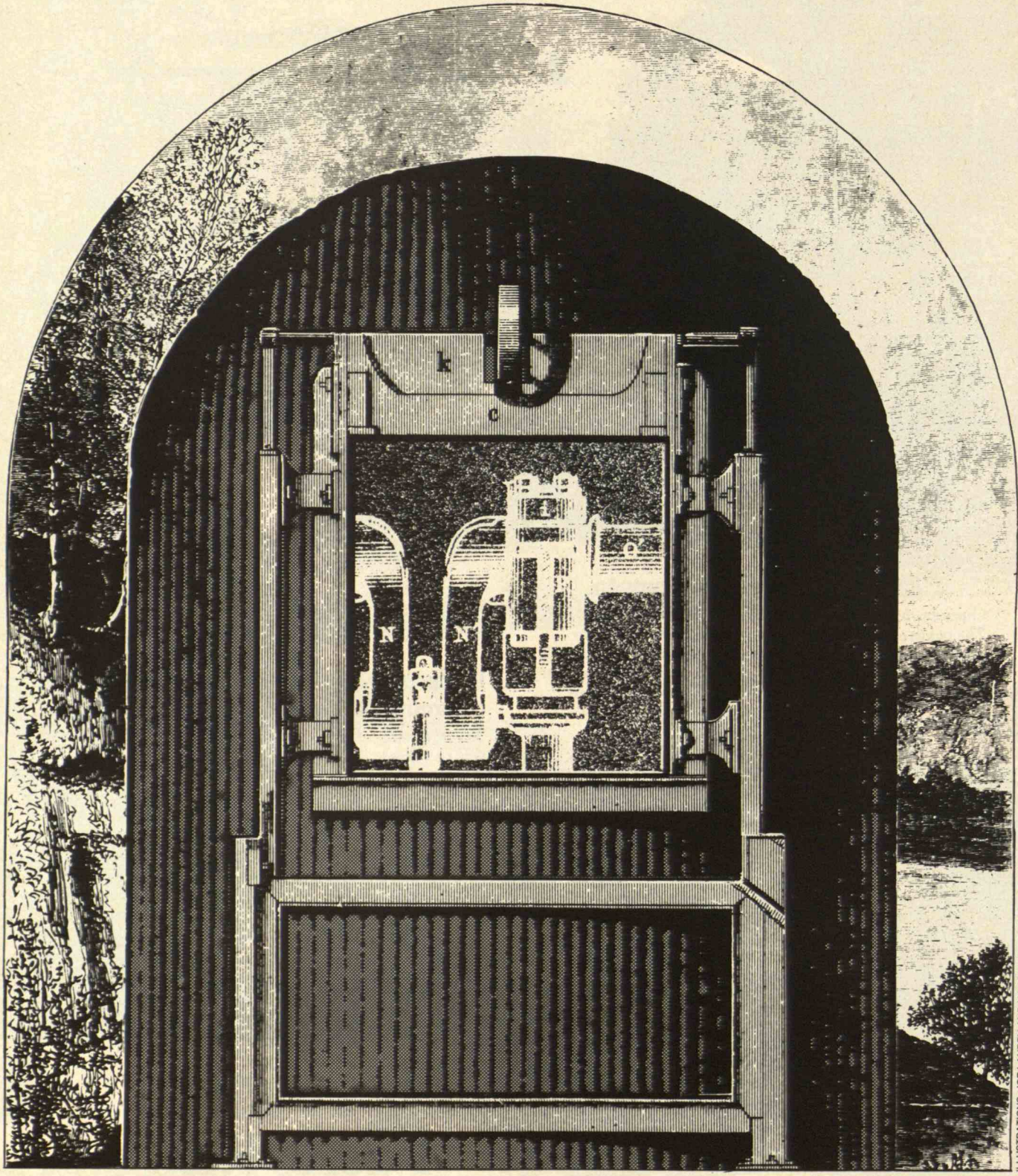

ILLUSTRATIONS: JOE LANDRY AND NANCY LINDGREN

What Makes Nuclear Power Plants Break Down?

by Steve Thomas and John Surrey

The reliability of today's nuclear reactors generally needs improvement, so standardization of current designs is premature.

PUBLIC debates on nuclear power have centered on matters of safety and proliferation and the wider issue of centralized decision making. But the reliability of nuclear plants compared with expectations and the effect of reliability on energy costs have largely escaped public attention. The reliability issue will inevitably come to greater prominence as more nuclear plants enter service and their performance and costs are reflected in the price of electricity.

Nuclear plants have high capital costs and low operating costs relative to fossil-fuel plants, so they are operated at their full authorized rating whenever possible. Indeed, nuclear investment decisions involving huge, long-term capital expenditures are made with little knowledge of how current designs are likely to perform over the long term. When reactors are not available for service, or if they must operate well below their full rating, the cost of replacement power from other types of generating plants or utilities is usually very high. In view of the growing number of reactors worldwide and the changing regulatory climate, plant performance must be continually monitored to improve reliability and reduce investment risks.

Previous independent analyses of nuclear plant performance have generally focused on a particular country (usually the United States) and year and failed to examine the causes of reactor unavailability. With these shortcomings in mind, we undertook a study of all commercial nuclear plants in the non-Communist countries by 1978, including 17 countries with a total rated capacity of 91.2 gigawatts. Apart from readily identifiable prototypes, no plant is excluded even if its performance has been "unrepresentative."

Performance of nuclear power plants is usually expressed as a *plant capacity factor*, obtained by dividing actual output by maximum design output. To ensure that the capacity factor is a valid measure of reactor availability and performance, we examined the record of all commercial plants operating from 1975 to 1977. We found that only two units had operated, briefly, at reduced output even when available for service at their full authorized rating. All other output shortfalls were due to plant-related factors such as refueling, planned repairs and maintenance, and equipment failures.

Of the four types of commercial nuclear reactors, by far the most numerous are the pressurized-water

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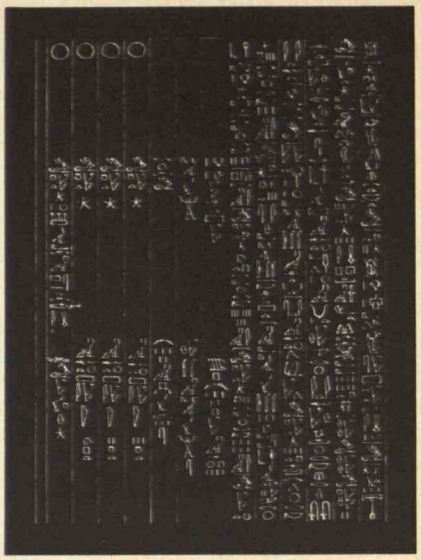

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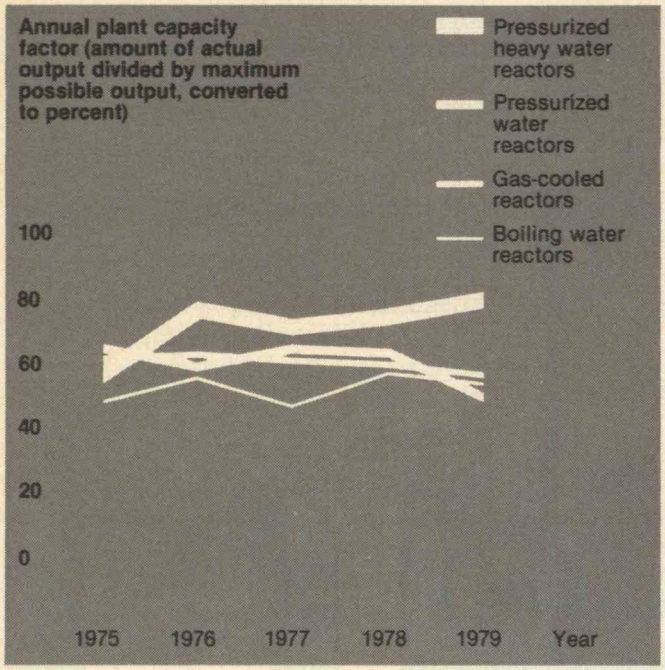
The performance of 152 nuclear power plants in 17 countries from 1975 to 1979. The *capacity factor* is the available capacity divided by design capacity. Pressurized heavy-water reactors had the largest capacity factors, while boiling-water reactors had the poorest record. Early designs of gas-cooled reactors were abandoned in 1965 because of high construction costs and relative inefficiency; an advanced gas-cooled design may be operating later this year. The track record of pressurized-water reactors was dealt a heavy blow by the accident at Three Mile Island in April 1979. All nuclear power plants sited in Japan suffered prolonged outages.



reactor (PWR) and the boiling-water reactor (BWR). In the PWR, cooling water is kept in the liquid state under pressure, which necessitates the use of large, thick, steel pressure vessels; in the BWR, cooling water is allowed to boil. Both types use enriched uranium fuel and must be shut down for three to six weeks per year to allow spent fuel rods to be replaced. Both reactor types were originally developed in the United States—the PWR by Westinghouse and the BWR by General Electric. They are now used throughout the world, notably in West Germany, Japan, France, and Sweden, as a result of technical licensing that enabled foreign suppliers to import, and even adopt, American technology.

Another type of reactor, the gas-cooled reactor (GCR), was developed in Britain and France in the 1950s, only to be abandoned in the late 1960s when construction costs grew too large. GCRs use carbon-dioxide gas as the coolant (with some advantage over water in intrinsic safety) and unenriched uranium fuel, and refueling does not require that they be shut down. In 1965 Britain opted for a more elaborate design, the advanced gas-cooled reactor (AGR), which promised greater efficiency and lower costs. However, construction difficulties have set back the whole program to such an extent that the first AGR ordered (Dungeness B, some 16 years ago) is not yet operating. The French abandoned construction of their very costly GCRs in 1969 and have pursued an aggressive program of PWR construction since 1973.

The fourth type of reactor, the pressurized heavy-water reactor (PHWR), uses heavy water as the coolant and unenriched uranium for fuel. Of the ten commercial PHWRs currently in service, nine are of the Canadian CANDU design; the other is a similar German design. PHWRs have two distinct advantages: the use of heavy water allows more efficient absorption of the energy released in the reactor, greater fuel "burn-up," and therefore fuel economy; and they can be refueled without being shut down. The great majority of reactors currently in service and under construction are light-water reactors ordered between 1967 and 1974. An initial surge in orders in the United States from 1967 to 1970 was followed by a second surge from 1972 to 1974 in the United States, Western Europe, and Japan. Since then, forecasts of reduced electrical demand, escalation of construction costs, and public resistance have led to a near-moratorium in orders and many cancellations.

Batting Averages

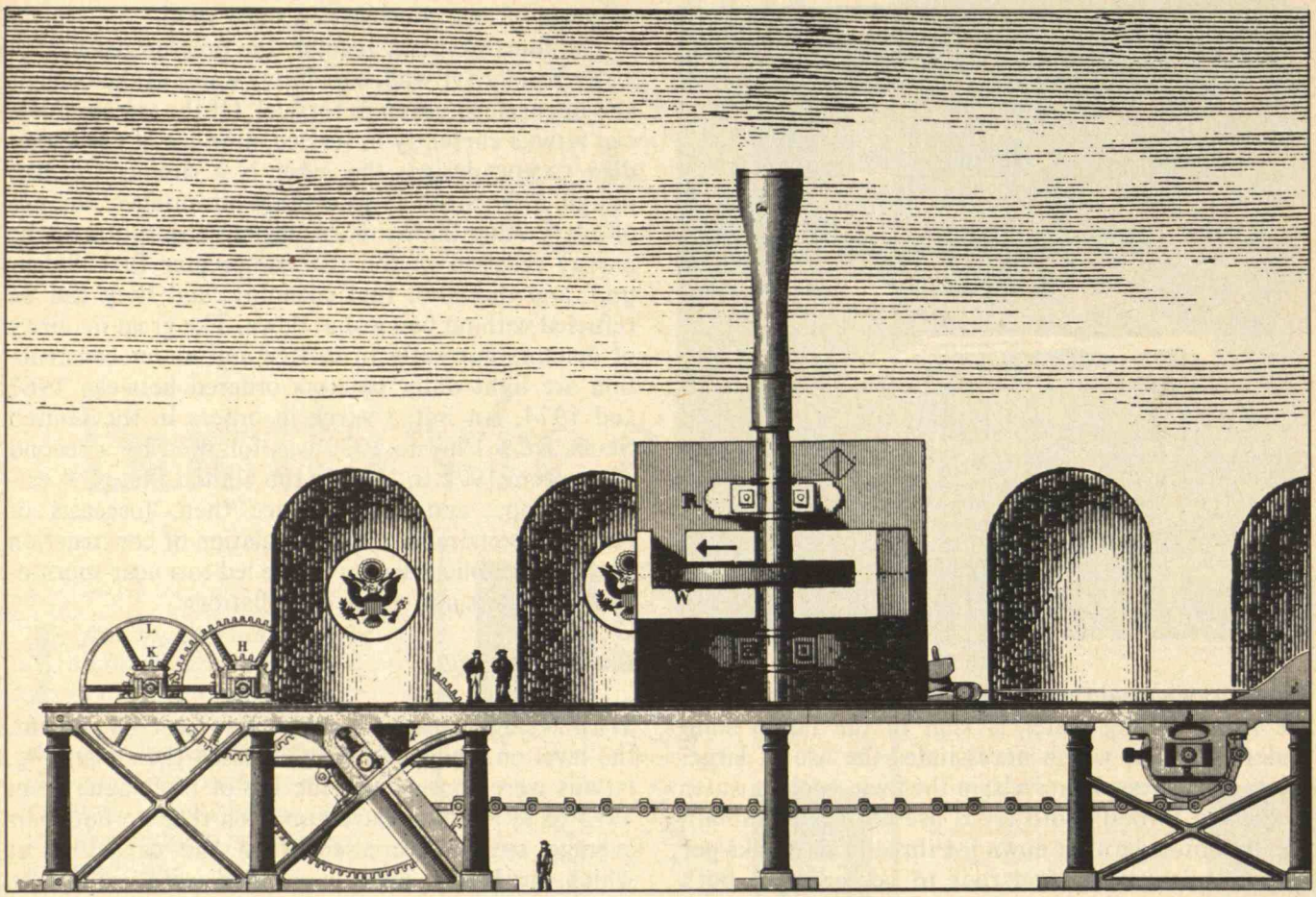
With average capacity factors of at least 70 percent, the level on which the utilities based their planning, PHWRs were consistently the top of the league from 1975 to 1979. GCRs have also been reliable but their average output decreased when the capacities at which the British units were rated were reduced to slow the corrosion of mild steel parts by the carbon-dioxide coolant.

Average PWR performance has fluctuated but has generally exceeded average BWR performance, which has remained at the bottom of the league—except in 1979, the year of the accident at the PWR at Three Mile Island.

PWRs and BWRs generally have greater planned outages and therefore lower capacities than GCRs and PHWRs, partly because they must be shut down for refueling, and partly because the low incidence of equipment failures among GCRs necessitates less planned outage for repair. And in the United States, requirements of the Nuclear Regulatory Commission for backfitting with new components have also caused shutdowns and affected capacity factors. These generic averages conceal wide variations among individual plants, however. Indeed, such variability is the dominant feature of nuclear plant performance, especially among light-water reactors, as reflected in the frequency and duration of unplanned outages.

We tried to explain the variability in the perfor-

Very few outages resulted from failures of "nuclear core" components, probably because of exacting engineering standards.



mance of nuclear power plants by means of regression analysis, following the lead of previous authors. Plant capacity factor was chosen as the dependent variable and age, size, coolant pressure, and temperature as the independent variables. We then performed separate regressions for PWRs and BWRs using the average capacity factor of individual plants for the two periods 1975 to 1976 and 1977 to 1978 (two-year averages were used to iron out performance fluctuations owing to refueling shutdowns).

But this analytical technique could explain only 7 to 21 percent of overall variability. Furthermore, there was no consistency in the relative effects of the explanatory variables between the two periods. The main difficulty with this approach is that age, size, and coolant conditions are not independent.

Maturation, Size, and Temperature Effects

Because regression analysis (even with the inclusion of additional independent variables) apparently could not explain the variation in capacity factors, we adopted a more empirical approach to test some common hypotheses about nuclear plant performance.

The first hypothesis is familiar enough: it holds that performance typically improves as start-up problems are overcome and plant operators learn the finer points of maintaining the reactor. After the plant has operated for two years, equipment failures will be infrequent until components begin to wear out much later. This hypothesis was based on the performance record of relatively small plants; unfortunately, today's large reactors of 900 to 1,200 megawatts have not matched the performance of smaller plants at comparable ages. (On-line experience can suggest when planned shutdowns to refuel BWRs and PWRs can permit the repair of defective equipment, possibly to prevent an unplanned outage.)

To try to understand the effect of maturation, we grouped reactors of similar characteristics and age. Using capacity factors for every year that each reactor had been in service, we were able to meter maturation

in a group of technically similar reactors and compare the performance of reactors of similar age but different technical characteristics.

There was clear evidence of maturation for all sizes of PWRs—but not prior to four to five years of operation, compared with the two expected. Units of 400 to 800 megawatts have consistently achieved an average capacity factor of over 70 percent from their fourth year on. Data for units larger than 1,000 megawatts are limited but suggest that their performance has so far been inferior to that of the 400-to-800-megawatt group of comparable age. The smallest and generally oldest PWRs were usually mediocre performers, although two relatively new small PWRs have done well. Furthermore, PWRs with lower coolant temperatures tended to achieve larger capacity factors than those with higher coolant temperatures. (Except among the oldest PWRs, coolant pressures have not varied much and have not significantly affected PWR performance.) Evidently, capacity factor decreases as reactor size increases and coolant temperature rises, but it is statistically impossible to separate the two effects.

Similar analyses on BWRs revealed no discernible maturation, size, or coolant effects. We noted that the performance of BWRs of all ages and sizes were less satisfactory and predictable than that of other types of reactors.

By contrast, nine of the ten PHWRs achieved 70 perent capacity factors from their first year, and the performance of larger units is similar to that of smaller ones. However, the size range, 320 to 791 megawatts, is smaller than for light-water reactors. The mediocre performance of the tenth PHWR (Rajasthan, in India) is ascribed by the utility to "grid disturbance"—factors unconnected with the plant itself.

The record of GCR performance is heavily influenced by the British reactors, which account for 20 of the 26 operating in 1978. Although the largest is rated at only 676 megawatts, GCR performance tends to decline with increasing size and as coolant conditions become more severe. Only the smallest GCRs—rated at less than 200 megawatts of capacity—have average capacity factors exceeding 70 percent. And despite the deratings to mitigate corrosion, recent events suggest that GCRs are wearing out. Potentially serious cracking at several Magnox plants will necessitate lengthy outages; it is not yet known if similar cracks are present at other Magnox plants. Because they were designed for a 20-year life and most are approaching that age, repair costs could exceed the value of retaining the affected plants in service.

Variations in Manufacturers and Nations

The variation in performance among reactors may partly result from international differences in quality of maintenance and operator training and different levels of quality control among manufacturers. Of 51 PWRs operating on January 1, 1978, 39 were in the United States, 7 in Japan, and 5 in Germany. Thus, the average worldwide performance of PWRs is weighted toward U.S. performance, which was better than Japan's but worse than Germany's.

Among PWR manufacturers, Westinghouse as market leader set the average, Babcock and Wilcox units performed far below average even before the accident at Three Mile Island, and Siemens/KWU (West German) units have worked much better than Westinghouse units in all size ranges.

No country apart from Switzerland, which has only one unit, has had satisfactory performance from its BWRs. Several of the four units in West Germany and the seven in Japan were out of service for more than a year. All German BWRs will require extensive modification, and two units (Gundremmingen and Lingen) will be decommissioned after only ten years of service. The BWRs made by AEG/KWU (West Germany) have the poorest operating record; those of General Electric—again, the market leader—set the average; and those made by Asea Atom (Sweden) are the best of an unsatisfactory bunch.

Vintage Effects

Plants of the same age, technical characteristics, and make constitute a given vintage. Performance is generally expected to improve in successive vintages with design modifications and more efficient operation. In practice, it is difficult to test this hypothesis because few nuclear plants have sufficiently similar technical specifications, and even those that are similar can have significantly different major components.

Some indication of the importance of vintage effects can be gauged by comparing the performance of duplicate units on the same sites. We found that eight of ten duplicate units on nine sites in the United States performed appreciably better than their predecessors. This improvement probably stems from the learning achieved during construction, site management, and early operation and suggests the value of maintaining a close relationship among manufacturer, architect-engineer, and utility.

Equipment Failures

To determine the most common causes of unscheduled outages, we used utility reports of the duration and cause of plant outages for the three years 1975 to 1977, published by the International Atomic Energy Agency. Unfortunately, utilities report only equipment failures that necessitate *immediate* shutdown. Other less serious or potential equipment problems that are rectified or for which repairs can be postponed until the next planned refueling shutdown are not listed. Nevertheless, useful insights into the determinants of plant outage can be gained by analyzing the reported equipment failures.

Most lost hours occurred in rare and unpredictable prolonged outages. Thus, the outages for each main subsystem were not significantly correlated with age, size, and steam conditions.

For all three current types of nuclear plant, equipment failure accounted for three of four unplanned outages. In turn, three of four equipment failures were in "conventional," or nonnuclear, subsystems—the main heat-removal system, steam generator, feedwater-condenser system, and turbine generator. These subsystems must withstand mechanical stress and chemical corrosion of large flows of heat, steam, and water and the vibration and other stresses of heavy rotating machinery. In contrast, very few outages resulted from failures of "nuclear core" components, probably because of exacting engineering standards.

Half the outages from equipment failure in PHWRs and a smaller but significant fraction in PWRs and BWRs were rooted in main heat-removal systems. These failures were more prevalent among newer and larger plants. Almost half the equipment-failure outages among PWRs were caused by faults in the steam-generator and feedwater-condenser systems. A large proportion of the steam-generator problems caused long outages, some lasting more than a year.

Turbine generators caused nearly one-fifth of equipment failures in all types of power plants.

Until causes of outage
are better understood and effective remedies are developed,
standardization could well serve to reproduce
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design elements.

Among light-water reactors, the chief problems with turbine generators were erosion, corrosion, and fatigue of the blades in the low-pressure section of the slow-speed (1,800 rpm) saturated-steam turbine, together with unspecified generator faults.

The size of PWRs and BWRs seemed to play at least a statistical role in the frequency of equipment failure. Among large PWRs, equipment failures in the main heat-removal system and feedwater-condenser system were appreciably higher than among smaller plants, as were output losses from testing, regulatory limitations, and operator error. But steam-generator failures were appreciably lower among newer large PWRs, suggesting that tube leaks generally occur after an incubation period. Operator error was the biggest cause of outage among large BWRs, owing to the shutdown of the Brown's Ferry units following the notorious cable tray fire. With that exception, there were no important differences in the causes of unscheduled outages between larger and smaller BWRs.

All Japanese nuclear power plants have suffered prolonged outages, many exceeding six months. Japan's PWRs had persistent steam-generating problems, and the BWRs have experienced faults in control-rod drive mechanisms and leaks from corrosion and cracking in the pipework.

Premature Standardization

Recently there has been much interest among utilities and plant suppliers in total plant standardization. Standardization could well reduce licensing delays, construction costs, and equipment failures as manufacturers and utilities incorporate experience into plant design. But there remains the nagging problem of evaluating the causes of unpredictable performance. Vastly different implications for designers would issue from analyses that pinpointed generic design and materials defects, substandard site work, inadequate quality contol, and inappropriate treatment of cooling water. Until these causes of outage are better understood and effective remedies are developed, standardization could well serve to reproduce faults along with good design elements. Therefore, we favor continuation of incremental ordering rather than a long-term program of reactor standarization based on today's units. We base this conclusion on several of our findings:

Unpredictability. Excluding PHWRs, which have consistently performed well, the main feature of nuclear plant performance has been variability, which means that investment is risky. The risk is highest for small utilities, where a single nuclear plant represents a sizeable fraction of system capacity; and all utilities must consider the high cost of replacement power when nuclear plants are shut down.

Economic uncertainty. From an overall economic viewpoint, the fact that nuclear core components are reliable is irrelevant; an outage of given duration is serious in terms of replacement power costs no matter what its cause. Good performance can be achieved only if *all* components that cannot be replaced while the plant is in operation are equally reliable, including valves, pumps, and pipework. An on-site inventory of spare components can reduce the risk of prolonged outages, and sustained research and development to improve the reliability of "conventional" subsystems of nuclear power plants may also improve the reliability of similar subsystems in fossil-fuel plants.

Bigger is not better. Larger nuclear units, especially PWRs of over 1,000 megawatts, will continue to represent a greater investment risk than medium-sized PWRs of, say, 400 to 800 megawatts, unless reliability improves dramatically over the next few years.

Problems with suppliers and national standards. Replication of a given design may theoretically lead to better product reliability and lower costs, but the success of West German PWRs and the dismal record of both PWRs and BWRs in Japan carry another important message. To reduce recurring equipment failures that cause heavy output losses, manufacturers and engineers must ensure that the quality of components, structural materials, and site work is uniformly superior. If utilities are to anticipate and prevent failures, they must maintain experienced teams of operators, technicians, and maintenance personnel and encourage or even institutionalize continuing contact between plant engineers and the original design team. No single factor can guarantee success; continuing, meticulous attention must be devoted to every facet of nuclear plant design, construction, and operation.

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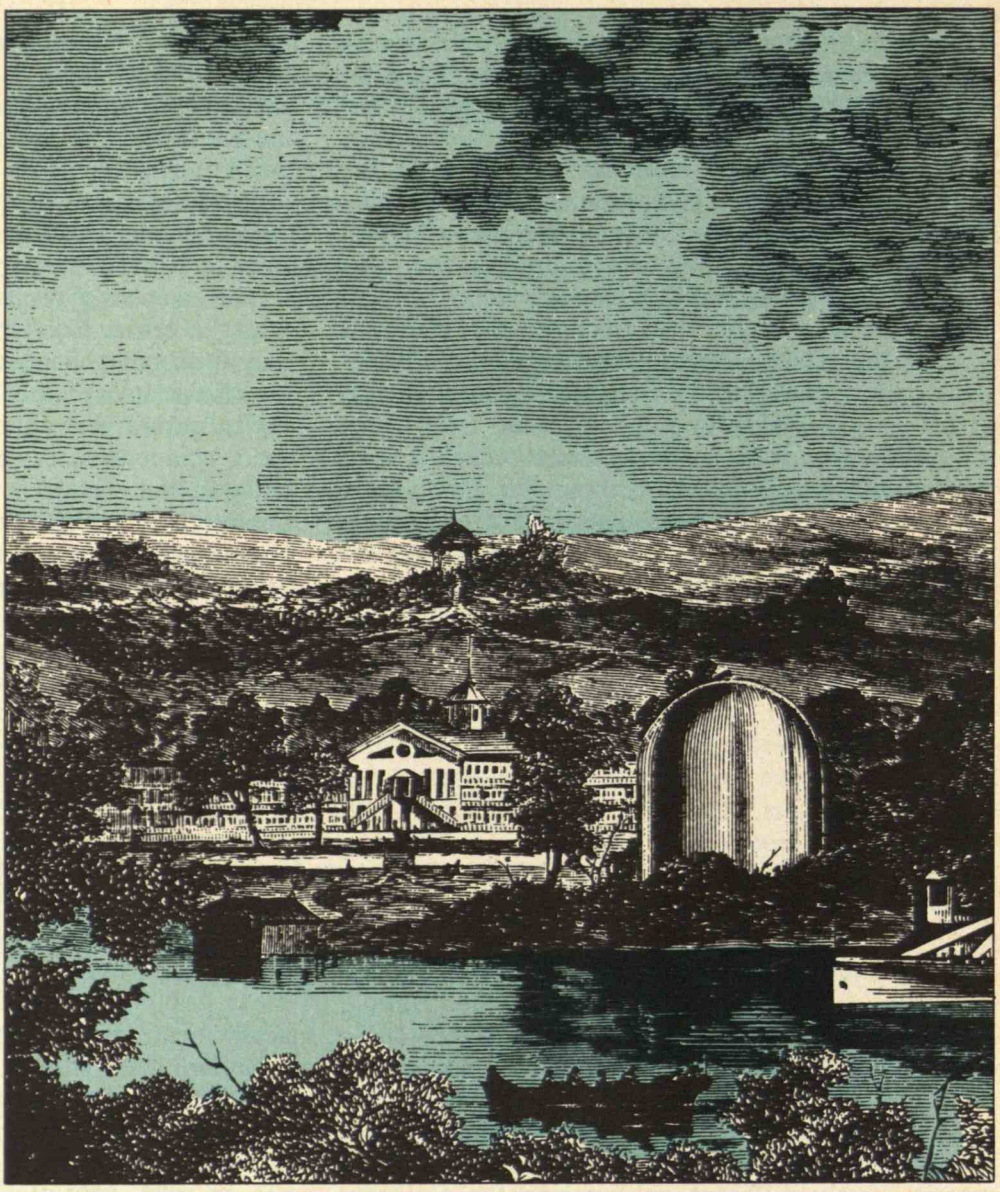
The Energy Programme is funded by the British Research Councils, the Department of Energy, and the British fuel industries. This study is part of an ongoing research program on the technological, economic, and social aspects of nuclear power.

A Nuclear Power Plant In Whose Backyard?

by Walter Cooper



THE authority to regulate the nuclear power industry resides largely with the federal government. But states have the responsibility to protect the health and safety of their citizens and to regulate land use within their borders. The siting of nuclear power plants can engender conflicts between these jurisdictions that are usually resolved in the courts.

Most state challenges to federal control of nuclear power have been struck down or severely weakened by the preemption doctrine contained in the supremacy clause of Article VI of the Constitution, which provides for the preemption of federal law over state law in the event of direct conflict. The existing avenues for state control over siting and operation of nuclear power plants can be greatly strengthened while avoiding direct conflict with federal jurisdiction.

State authority over certain aspects of nuclear power has stemmed largely from "permission" granted by Congress. Initially, the federal government exercised full control over atomic energy through the Atomic Energy Act (AEA) of 1946, which gave the Atomic Energy Commission (AEC) control of civilian uses of nuclear power. The AEA was amended in 1954 to allow private involvement in the new nuclear power industry, leading to state concern over public health and safety. However, state jurisdiction was possible only in the distinctly nonradiological areas of interstate sales and transmission of power.

In 1959 the AEA was amended to give the states limited jurisdiction in matters involving nuclear power through the Agreement States Program. The program authorizes states to regulate quantities of radiological materials too small to reach critical mass for the "protection of public health and safety from radiation hazards." The AEC retained authority over the regulation of all phases of nuclear power plant construction and operation, imports and exports of radioactive materials, and disposal of radioactive waste. This allowed *direct* state authority over nuclear power plants for "purposes other than protection against radiation hazards." Thus, the interpretation by the courts of "radiation hazards" became critical in disputes between state and federal governments in the siting of nuclear plants.

Federal Preemption Put to the Test

In a landmark decision in 1971, a federal court upheld preemption of state powers in the siting of a Minnesota nuclear power plant (*Northern States Power Co.* v. *the State of Minnesota*). Applications for permits to build and operate the plant were filed in 1969 by Northern States Power Co. with the AEC and the Minnesota Pollution Control Agency, but the state's radioactive emission requirements were more stringent than those of the AEC. The AEC granted an operating license to the utility, but the

utility chose not to satisfy the stricter state requirements and went to court seeking a judgment that would preempt the Minnesota regulations. (Minnesota was supported by"friends of the court" briefs filed by Michigan, Wisconsin, Illinois, Maryland, and Vermont.)

The lower federal court held that "Congress intended federal occupancy of regulations over all radiation hazards except where jurisdiction was expressly ceded to the states," and that the AEC "was expressly prohibited from turning over to the states its authority and responsibility with respect to the regulation of . . . nuclear power plants." The decision was upheld by the U.S. Supreme Court in 1972, and the final opinion included three specific findings: the federal government has clear authority over radiation hazards; any state authority is "ceded" by the Agreement States Program; and there is a distinction between radiological and nonradiological aspects of nuclear power production.

The Blossoming of Environmental Law

The passage of four key pieces of environmental legislation in the late 1960s and early 1970s broadened both state and federal authority over nonradiological matters. Consequently, the distinction between state and federal jusisdiction is not so clear-cut as when the AEA was the only law governing the siting of nuclear power plants.

■ *The National Environmental Policy Act.* Passed in 1969, NEPA was designed to promote public health and welfare through the environment without "degradation, risk to health and safety, or other undesirable and unintended consequences." To fulfill these goals, NEPA requires the preparation of an environmental impact statement for each project requiring "major federal actions significantly affecting the quality of the human environment."

As a result of *Calvert Cliffs Coordinating Committee* v. *the AEC,* the federal licensing process for nuclear plants was determined to be a "major federal action" requiring an environmental impact statement. Under NEPA, the states could appear as intervenors to assure that the review process was followed, and in effect they assumed a measure of control over nonradiological issues. However, the limits of state and federal jurisdiction became less distinct.

The confusion is exemplified in *In Re Consolidated Edison Co. of N.Y.,* which concerned local zoning ordinances prohibiting cooling towers. As noted in the environmental impact statement filed by Con Ed, cooling towers were needed and required by the Nuclear Regulatory Commission to alleviate a potential thermal pollution problem in a proposed nuclear power plant. (The NRC, along with the Energy Research and Development Administration [ERDA], replaced the AEC under the Federal Energy Reorganization Act of 1974. ERDA was later absorbed into the Department of Energy in 1977.)

Three different opinions handed down in three separate proceedings blur the limits of state jurisdiction over nonradiological matters. The state trial court held that the cooling towers should be erected; the N.Y. Court of Appeals then reversed that decision to permit "reasonable incidental [state] regulation." The NRC's Atomic and Safety Licensing Board ruled that state laws hindering licensee compliance with NRC regulations were invalid.

■ *The Coastal Zone Management Act.* The CZMA, passed in 1972 and amended in 1976, permits any participating coastal state to regulate facilities, including nuclear powerplants, in or affecting its coastal zone. The act stipulates that pertinent federal actions must be consistent "as far as practicable" with a state's coastal zone management plan, with consistency determined by the state. However, practicability is determined by the federal government, providing an avenue for federal preemption. The limits of state authority have not been tested, but the CZMA does offer some basis for state control over nuclear plants.

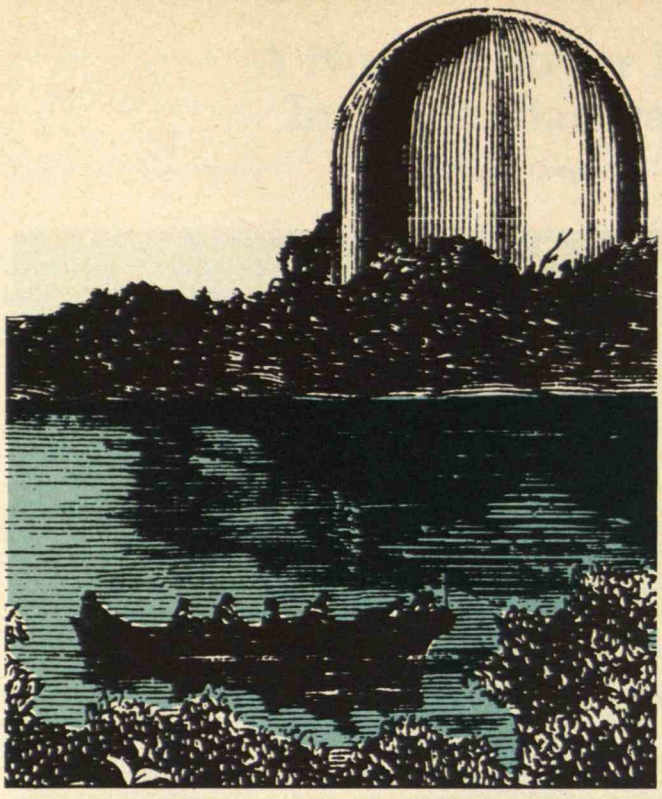
■ *The Federal Water Pollution Control Act, now the Clean Water Act and the Clean Air Act.* The Clean Water Act (CWA) allows states to regulate, under federally approved plans, the thermal discharge of cooling water from nuclear power plants, but radiologically polluted water is under the control of the NRC as established in *Northern States.* (The NRC cooperates with the Environmental Protection Agency [EPA] through a "memorandum of understanding" on water-quality matters involving nuclear power plants, thereby avoiding jurisdictional conflicts.) The Clean Air Act (CAA) as amended in 1977 gives states the authority to control air pollution, including radioactive discharges into the air from nuclear power plants. While the act forbids the implementation of standards less strict than those specified by the EPA (the administrator of the act), it does not specifically prohibit states from setting *stricter* air emission standards, radiological or otherwise. Thus, this provision may empower states to control the siting or operation of a nuclear plant through the promulgation of very stringent air pollution regulations, a premise yet to be tested.

The Struggle for Power

In view of federal preemption in radiological matters, states can most effectively increase their siting authority by concentrating on nonradiological matters. This control should be based on their right to exercise police powers as granted by the Tenth Amendment to the Constitution. Attempts by the states to regulate nuclear power plants are likely to be regarded by the courts as an intrusion into federal jurisdiction. The federal position is further reinforced by the national policy of achieving energy independence and the current perception that nuclear power has a strong role in that policy. However, Maryland, New York, Ohio, and several other states have exercised indirect regulatory power over siting; California has not been so successful.

California recently enacted three statutes that constrained the future development of nuclear power. To avoid preemption, the state scrupulously skirted questions of radiological safety, basing its approach on land use, a traditional area of police powers. Nonetheless, the federal courts found the state laws unconstitutional.

The first statute denied land use to plants requiring the reprocessing of fuel rods until a federally approved technology for such reprocessing was developed. The second and third prohibited using land until the federal government approved a technology for the disposal of high-level nuclear wastes, and until the state studied the feasibility of underground and berm containment of nuclear reactors. Two federal court decisions,



Pacific Legal Foundation v. *ERDC* and *Pacific Gas and Electric* v. *ERDC,* held that the three state statutes "obstruct the accomplishment and the execution of the purpose of Congress, manifested in the Atomic Energy Act," and were therefore unconstitutional.

Maryland's power plant siting laws are based upon the state's determination of a need for power, and on its ability to acquire land for the siting of future power plants, called "site banking." Both approaches are grounded in traditional state powers, do not infringe on federal jurisdiction of radiological controls, and apply to all types of commercial power plants. Thus, Maryland's controls appear to be safe from federal preemption, with at least three nuclear plant projects delayed or killed by the application of these siting criteria.

New York's control over the siting of power plants is based on the need for power as well as the requirement that two sites be thoroughly considered as locations for nuclear plants. These criteria were successfully tested in two recent cases.

In 1974 the NRC and the New York Siting Commission issued construction permits to Rochester Gas and Electric to build a 1,150-megawatt nuclear power plant in Sterling, but the state suspended its authorization in 1978 because of a decline in the forecast of the need for power. (Interestingly, New York, unlike Maryland, relies on the utilities and other nonstate sources for its power forecasts.) Despite NRC approval of the project and the considerable amount of money already spent by the utility, the permit was rescinded. In a similar recent proceeding, the New York siting board rejected a proposed nuclear facility in Jamesport because the projected need for power declined.

The Ohio Public Service Commission reserves the right to regulate what the NRC does not. Ohio recognizes federal preemption with respect to radiological hazards but maintains its own authority to complement federal regulations.

States that regulate plant financing can also exercise control over the siting of commercial nuclear power plants. For example, Missouri utilities have been prohibited since 1976 from financing new facilities by passing the costs on to consumers prior to the production of electricity. This ruling stems from the 1954 amendments to the Atomic Energy Act, which preserve the authority of states to regulate utility rates.

Iowa utilities must obtain a certificate of public convenience, which guarantees that a proposed power plant will not be an economic detriment to consumers.

Vermont pragmatically negotiates standards with power companies. The state can encourage a utility to adopt stricter conditions than those imposed by the NRC under a 1975 law that requires the legislature to approve a plant before the Public Service Commission can grant a construction permit. Because utilities may *of their own volition* exceed NRC standards, the preemption question is avoided. This strategy has been used to encourage the Yankee Nuclear Power Co. to agree to meet several state-imposed conditions—including radiological standards—that are stricter than those of the NRC.

The Future of State Authority

Despite some noteworthy successes, it is doubtful that states will gain more than very limited regulatory control over nuclear power plants; outright prohibitions are virtually impossible. Therefore, state regulation must be positive, allowing plants to be sited if criteria on court-tested nonradiological isses are met. Precedents strongly suggest that regulations enforcing these criteria are most likely to withstand federal preemption if they apply to all types of plants and are based on federally approved state plans such as management of coastal zones and air and water quality, and on traditional states' rights to regulate rates.

State control of nuclear plants may also be achieved indirectly by requiring that nonnuclear alternatives be considered as a part of permit applications—the applicant would have to justify siting a nuclear plant over alternatives. Unfortunately, the development of alternative sources could cause stabilization or even reduction of utility profits, earning little support from utilities and their shareholders.

In another approach, states that share interstate power grids could make regional agreements on energy planning. Utilities within such a regulatory regime would avoid the confusion of individual state regulations, but the powers and interests of individual states would be subordinated to the regional authority.

Certainly the means of regulating nuclear power plants at the state level can be strengthened. Unless such authority is developed, the federal government will maintain virtually total control over plant siting. If this condition prevails under a national energy policy that includes nuclear power, people who do not want a nuclear reactor in their backyard will have very little to say about it. □

Walter Cooper is the coordinator of the Rhode Island Coastal Energy Impact Program, a federal grant/loan program to assist states in assessing and minimizing the impacts of energy development. He holds a master's degree in marine affairs from the University of Rhode Island, specializing in energy issues and coastal zone management.

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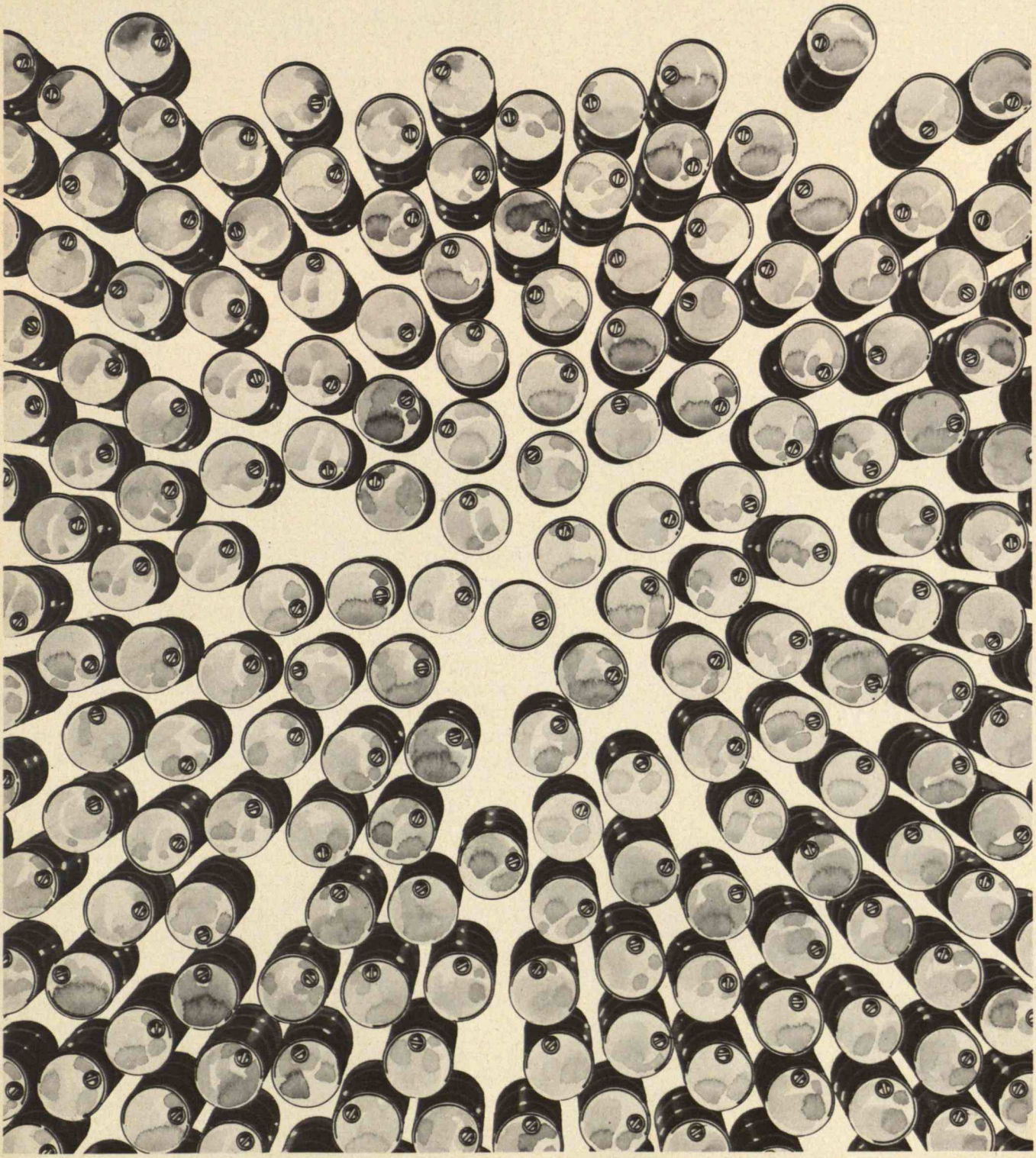
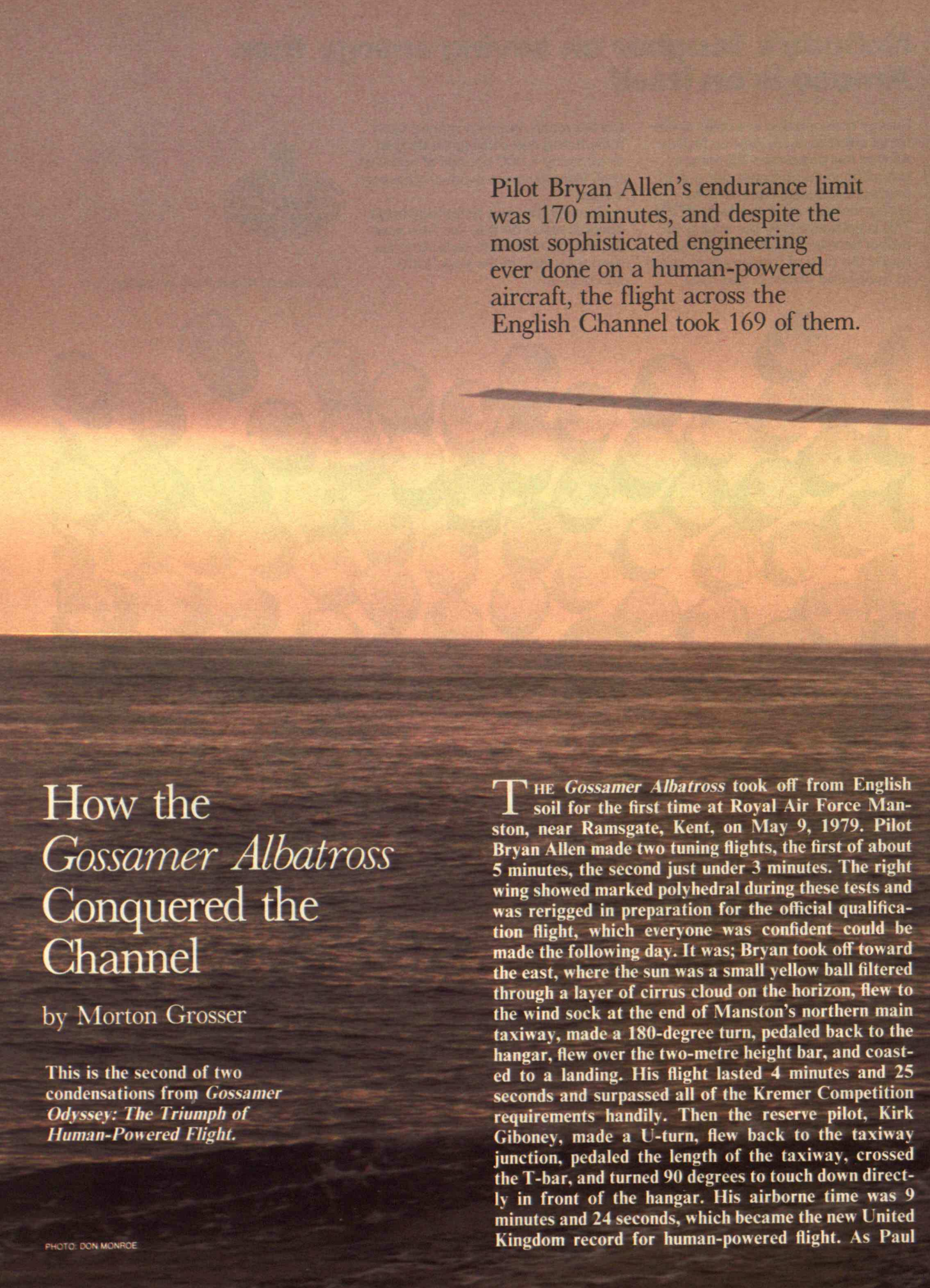




Pilot Bryan Allen's endurance limit was 170 minutes, and despite the most sophisticated engineering ever done on a human-powered aircraft, the flight across the English Channel took 169 of them.

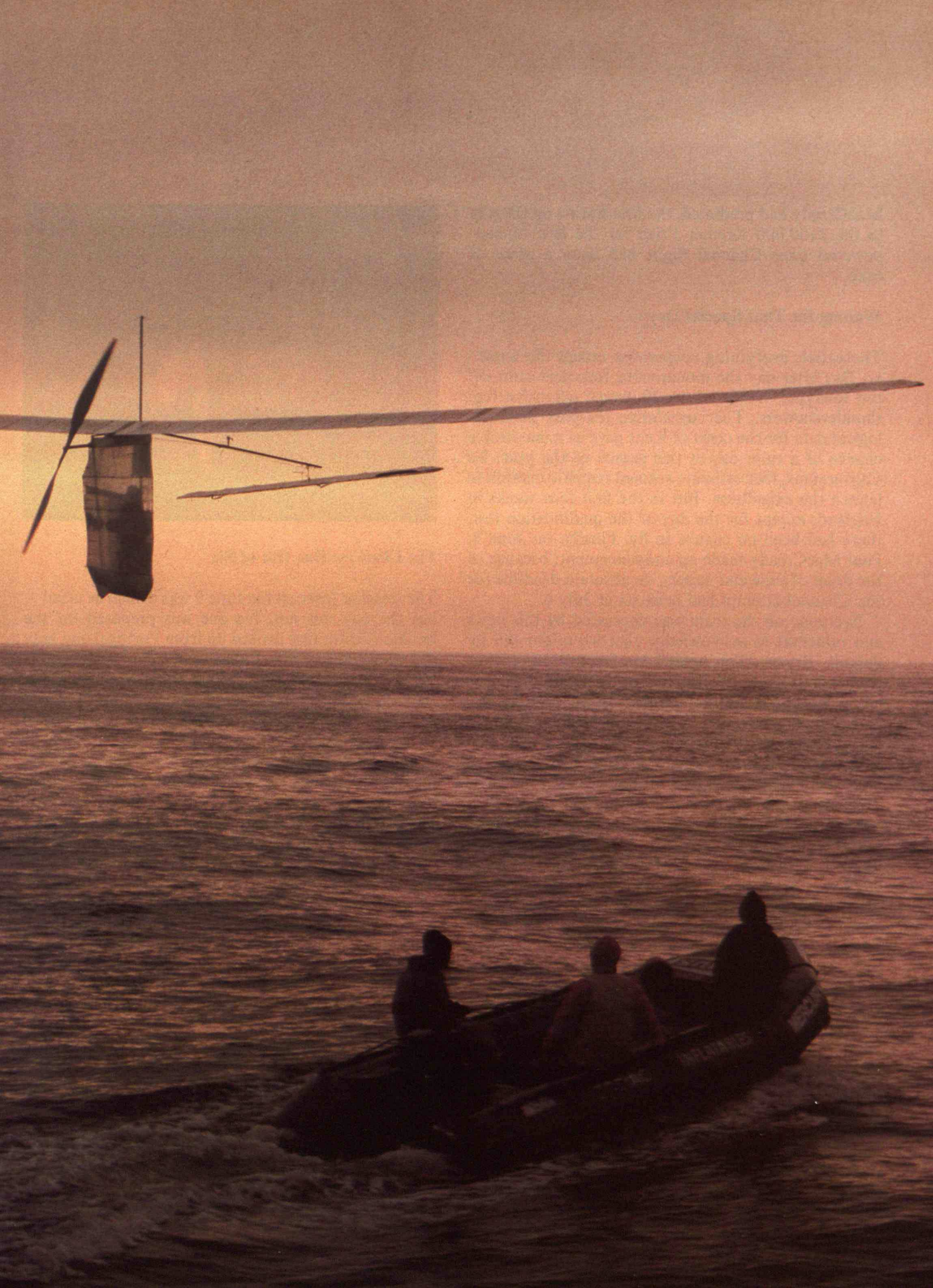
How the *Gossamer Albatross* Conquered the Channel

by Morton Grosser

This is the second of two condensations from *Gossamer Odyssey: The Triumph of Human-Powered Flight.*

PHOTO: DON MONROE

THE *Gossamer Albatross* took off from English soil for the first time at Royal Air Force Manston, near Ramsgate, Kent, on May 9, 1979. Pilot Bryan Allen made two tuning flights, the first of about 5 minutes, the second just under 3 minutes. The right wing showed marked polyhedral during these tests and was rerigged in preparation for the official qualification flight, which everyone was confident could be made the following day. It was; Bryan took off toward the east, where the sun was a small yellow ball filtered through a layer of cirrus cloud on the horizon, flew to the wind sock at the end of Manston's northern main taxiway, made a 180-degree turn, pedaled back to the hangar, flew over the two-metre height bar, and coasted to a landing. His flight lasted 4 minutes and 25 seconds and surpassed all of the Kremer Competition requirements handily. Then the reserve pilot, Kirk Giboney, made a U-turn, flew back to the taxiway junction, pedaled the length of the taxiway, crossed the T-bar, and turned 90 degrees to touch down directly in front of the hangar. His airborne time was 9 minutes and 24 seconds, which became the new United Kingdom record for human-powered flight. As Paul



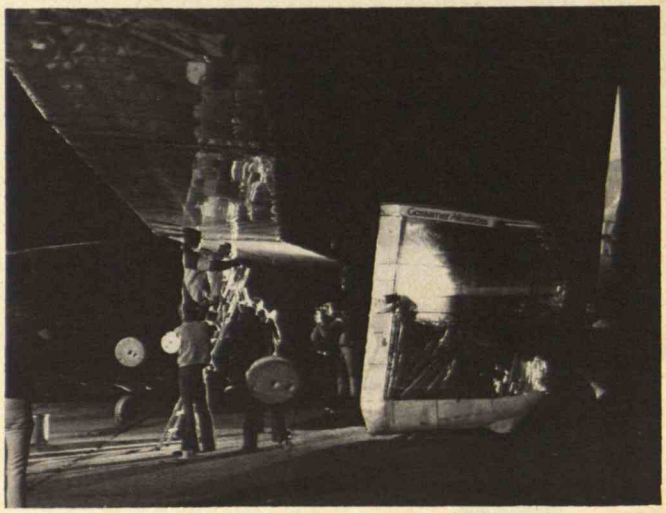
MacCready had predicted, the first hurdle on the way to the £100,000 Kremer Prize for the first human-powered cross-Channel flight had been a piece of cake.

Waiting for That Special Day

Thereafter, everything cooperated except the weather. Day after day the monotonous forecasts came off the teletype: Winds 15 to 20 knots; extensive fog; thundershowers. The cumulative ten-year meteorological data for the coast of Kent gave us a one-in-five chance of a calm day at this season of the year. To Californians, that estimate seemed realistic enough to launch the expedition. But in the first four weeks in England, except for the day of the qualification test, there had been no chance to fly. Finally, on June 5, Paul MacCready made an announcement: because of the drain of time and money, an absolute deadline for the Channel attempt had been set at July 6.

Everyone on the team was depressed by this news and reluctant to acknowledge that we might fail by default. Bryan Allen vented his frustrations with a tremendous workout climaxed by a series of five gruelling 30-second sprints. On the last of these he was pedaling at an awesome rate against heavy resistance; the floor around the ergometer was soaked with perspiration, and Bryan was pulling in air like bellows as Dr. Joe Mastropaolo counted him down: "Five...four...three...two...one...stop! Well done!" The whole team burst into applause. Partly on the basis of that 0.8-horsepower performance, Allen's still-air endurance limit in the *Gossamer Albatross* was calculated at 170 minutes, well over the 1-hour-and-50-minute flight time that MacCready estimated for the crossing. His water transpiration rate was one litre per hour, an amount that had to be replenished at the same rate to keep his muscles functioning properly.

Bryan's unstinting effort cleared the air, and later everyone was invited to the Olde Cliffe Tavern for a California barbeque. The first reaction was puzzlement: it is unlikely that the tiny Kent village had seen this particular genre of feast. There were platters of homemade tortillas, homemade *salsa,* potato salad, tossed salads with avocado, guacamole, grill-your-own hamburgers, unlimited beer, and the pièce de résistance, an authentic chile con carne. "My God," one of the Englishmen gasped after tasting the chile, "You people are unbelievable. You must have steel stomachs." "Good vibes," the team agreed, and two days later there was a sign that they were right.

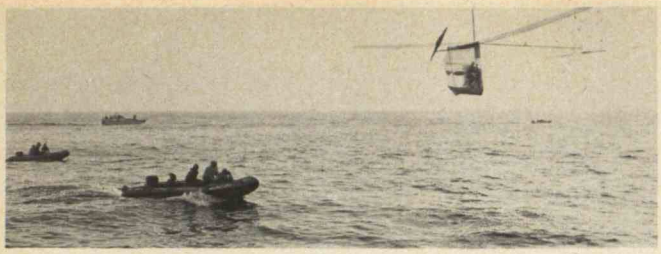


The Chances: One Out of Six

The weather forecast for June 9 was dismal as usual—but the day was not. No one was prepared for the bubble of calm that drifted up from Portugal and kept the wind light all day. "Missed it!" Paul wrote in his log, but we felt alerted. If there could be one bubble, there could be more. Although the prediction was still bad for Sunday, June 10, on Monday there seemed to be a break.

Paul MacCready was famous in soaring circles for his intuition about the weather, and on that morning of June 11 he was watching it like a hawk; everyone sensed the air of expectancy. London reported that a small high-pressure area was gradually moving southeast from the center of England, and at 3 P.M. the RAF weather office at Manston predicted five-knot winds, south to southeast, and three-kilometer visibility for the dawn hours of June 12. The long-range forecast included higher winds and sea fog. We had waited 35 days for this less-than-perfect chance. Paul made the decision: the flight was go. His private, written estimate of our chances at that moment was one out of six.

So it was that at 12:30 A.M. on June 12, the doors of our storage shed on the coast near Folkestone, Kent, were opened to reveal the young watchman listening to pop music on the radio and reading the *Kent Evening Post* by the light of a kerosene lamp, the parts of the *Gossamer Albatross* hanging on cords from the ceiling. One crew member says that he will never forget the atmosphere of that moment—it was like walking into the Wright brothers' hangar at Kitty Hawk.



June 12, 1979: predawn assembly of the *Gossamer Albatross* at the Warren, Folkestone, Kent; chase boats shepherding the *Albatross* in the early morning calm of the English Channel; and pilot Bryan Allen wearing a new T shirt, victorious after pedaling for 169 minutes at 80 rpm. (*Photos: Don Monroe*)

At 2:10 a rented mobile generating plant was started up, and the scene was starkly illuminated by its overhead lights. In blessedly calm air, Bryan Allen joined others on the team to carry the parts of the plane out of the shed and assemble it on the pad. At 2:30 the inboard wing panels were lifted into place and bolted and pinned together. Then Bryan attached the canard and checked the control rigging as he usually did at home—but this was definitely not home.

After the beautiful early morning solitude of Shafter, Mojave, and Harper Dry Lake, it seemed bizarre to assemble the *Albatross* in the glare of movie lights and strobe flashes. By now the pad was crowded with reporters and camera crews; no conversation was safe from their probing shotgun microphones, and Paul MacCready could not move anywhere without being followed by a cluster of them. His first answer as to whether the plane would fly was that "the wind here and at Cap Gris-Nez is still, but at mid-Channel it is still five to six knots, and on that basis we would have too long a flight." The team weather queries were coming to Cap Gris-Nez at about 20-minute intervals, and the same answer came back each time: "We have zero wind at Cap Gris-Nez." Others were also dubious about the attempt, expecting that it was going to be no more than a good full-scale practice. But Bryan methodically fueled up on carbohydrates: two apples, two bananas, and a large fruit-laden sweet roll. By 4:20 the crew was putting down the takeoff runway—a strip of hardboard sheets laid end-to-end over the rough concrete surface of the pad—and Bryan was stripping off his blue-and-white warm-up suit and knitted wool cap. (His minimal flying outfit consisted of white shorts, black leather bicycle racing shoes, a lightweight orange life vest, and a white bicycling helmet; he considered changing from metal to plastic glasses frames for the flight but decided to stay with ones that he knew were comfortable.) He was helped into the cockpit and the door was taped shut. At 5:10 he reported that he was ready; and then, with the press cameras grinding, he started his takeoff roll.

A few seconds later the boat crews were stunned to see the *Albatross* suddenly slam to an abrupt stop and tip over forward. The plane had crabbed off the left side of the hardboard runway and the plastic front wheel had run into an isolated deep hole in the concrete pad and shattered. The stop was so sudden that Bryan's glasses had shot off into the bottom of the fuselage, fortunately unbroken. There was no other visible damage to the plane.

In ten minutes a missing spacer had been improvised from duct tape and the fractured wheel replaced. Some sheets of British Rail plywood were used to extend the runway toward the eastern edge of the pad. Bryan got back into the cockpit and the door was taped shut again while MacCready anxiously scanned the rapidly lightening sky. At Cap Gris-Nez a faint easterly breeze had begun to come up—a headwind.

Bryan was told to go ahead whenever he was ready. "Okay, there's a bit of a lull now, so I'm gonna go right now." This time the *Albatross* began to accelerate steadily, faster and faster as Bryan poured power into the propeller that was designed for efficient cruise rather than easy takeoff. Crew members running beside the plane heard the wheel clicks between sheets of plywood as if they were rail joints and the airplane were racing a train on the British Rail line a hundred feet above. June 12, 1979: at 5:51 A.M. local time, 04:51 Greenwich mean time, the *Gossamer Albatross* lifted off the edge of the Warren near Folkestone, England, and set a course for France.

Blériot, Nous Sommes Ici!

The plane was heading east by north as it took off, and once airborne, Bryan began a sweeping right turn that would line him up with the waiting escorts. A few moments later the *Albatross* was soaring silently over the team's four idling inflatables like the great white bird it was named for.

"Altitude fifteen," Bryan reported over the radio.

"Roger, let's see if you can bring it down to ten,"

Paul B. MacCready: How to "Reach for the Stars" and Succeed

Just a year after the events described in the accompanying article, Paul B. MacCready made a commencement address at Worcester Polytechnic Institute to talk about some of the lessons learned in two remarkable achievements in human-powered flight. Here are excerpts from his June 1980 presentation.

DAN MONROE

Paul MacCready at Folkestone, June 12, 1979.

WHILE working on first the *Gossamer Condor* and then the *Gossamer Albatross*, we focused single-mindedly on the simple goal of winning the prizes put up by Henry Kremer, but we are beginning to realize that our projects were pretty special. They demonstrated approaches to solving technical problems and handling management tasks that may be applicable elsewhere. All this does not mean we are unusually bright or efficient. In fact, one of the important lessons is that rather ordinary people, with a bit of luck and strong drive, can literally "reach for the stars" and succeed.

These are the outstanding points as I think back over the *Gossamer* aircraft programs:

You can do amazing things in efficiency and energy conservation when you are really pushed—and the things you can do may be very important in these days of noninfinite energy resources.

Before I thought up the *Gossamer* aircraft, it never occurred to me (or others) that a person could fly on just one-quarter horsepower—or that you could make a 96-foot-wingspan airplane that weighed only 55 pounds. But I was pushed by the lure of Kremer's prize money, because I had guaranteed a friend's debt that wasn't paid. I think Kremer put up his prize money for just this reason—to push people to reach the goal. (Our project turned out to be more expensive than I had hoped, so much of the profit was an illusion, but the initial push was there.) It's one more example that almost any circumstance can eventually be turned to benefit.

Someone can certainly make a better human-powered airplane than the *Gossamer Albatross*, but my own motivation is now toward another area of greater interest and importance—ultraefficient surface transportation. Virtually everyone on the *Gossamar Condor/Gossamer Albatross* teams is also involved in the development and racing of streamlined bicycles. Each year, the International Human-Powered Vehicle Association sponsors exciting races in Southern California for these exotic vehicles. The vehicles all involve enclosing the occupant (or occupants) in a streamlined fairing and rolling on bicycle-type wheels, with bicycle pedals and sprockets or equivalent mechanisms. And each year you see people moving faster across the surface of the earth under their own power than ever before.

In 1979 a two-person machine first exceeded 55 miles per hour. Last year a single-person machine went faster than 55 miles per hour, while a tandem machine exceeded 100 kilometers per hour, almost 63 miles per hour. That same two-person machine, in a one-hour race, went 46 miles—a mind-boggling feat!

These surface vehicles are no more "practical" than our human-powered aircraft, but in them you can see the rudiments of something very practical. The discipline of seeking high performance with puny human power allows you to see and understand just how efficient vehicles can be—and with this understanding you are free to use various power sources, such as human pedaling, an electric motor powered by a battery or solar cells, a tiny gasoline engine, wind-aided motion, even a large rubber band, or combinations of these. You could mass-produce an all-weather vehicle, retailing at just a few hundred dollars, that protects you in a crash-resistant cocoon, powered, say, by an eight-pound battery/electric-motor system augmented by pedaling as desired, in which you could commute at about 30 miles per hour while maintaining your body in good physical condition. You may think such a Mickey Mouse device would never fit into our present transportation system, but just wait until OPEC turns off our oil imports for three or four months; our perceptions would then change very quickly.

It is useful to approach a problem with a knowledge of fundamentals but without the deadening influence of prior detailed expertise and prejudice. I see that the main factor in our success was our vehicles' structure—and the main reason that we came up with the right structure was that I had no background in aircraft structures. Every other serious team had excellent credentials in aircraft structural design, and what every team built looked, structurally, like a regular airplane or glider. But that was not the right approach for this sort of pioneering vehicle. My background included some fundamentals in beam bending and buckling, and those fundamentals were helpful. But basically this design was started with a clean slate (with some knowledge of wire-braced indoor models and wire-braced hang gliders).

There is, of course, a vital role for the experts, and I would rather fly in a jet airliner designed structurally by such experts than by anyone

with my poor credentials in structures. But experts entering a new area have to recognize that their expertise may inhibit their search for solutions. I began noting various instances where knowledge stifles solutions—and noting that this happens more often than expected.

For example, I was discussing with a 10-year-old how you put a needle on water and have the surface tension keep it afloat. The question was, how can you set on the water the largest possible needle that could stay afloat? How would you lower it and release it delicately? With your fingers? With tiny wire hooks? With an electromagnet? After a little discussion, the 10-year-old said, "Freeze the water, set the needle on it, and let the water melt." Would that really work? I suspect so. But I could not have thought of that solution because in my youth I had set needles down with my fingers, and my mind was blocked toward more ingenious ways of setting the needle down carefully. The 10-year-old, even though afflicted with dyslexia, did not have my blinders. He understood what question I was asking better than I did—the question was how do you get the largest possible needle to float on the water, not how do you set it down. I had introduced an unnecessary constraint.

A Nobel laureate in physics told me recently that he noted the greatest creativity in young physicists, and this usually involved ignoring a constraint that their elders had always presumed necessary. (As a last note on the needle incident, when I told the story to a friend, he said that when he was 10 he set the needles down on the water with a strip of toilet paper, which quickly dissolved away.)

Ten-year-olds have another attribute. They are perfectly happy to ask "dumb" questions (which may turn out to be not so dumb). As you get older, you think you should know the answer, and so you are ashamed to ask a question that might label you stupid. The most effective grown-ups are comfortable asking those "dumb" questions. Now when confronted with a new problem, I ask, "What would a 10-year-old say?" But I know in most cases I cannot come up with the 10-year-old's approach because years of experience have coated my originality.

All of us have the best chance of thinking clearly in new areas, where there is little precedent. Such areas are the most fun to work in, because you can make a significant impact without years of effort. After a field is so established that it is taught in college, the excitement is lessened, even though the importance of the field may have grown.

Technical aspects usually make up only a small percentage of the total program. Business management, determination, media interaction, timing, and luck—not the technical factors—are likely to be the major issues in any program. The rule that invention is 2 percent inspiration and 98 percent perspiration is surprisingly accurate. In the *Gossamer Albatross* program, probably 90 percent of what we did could be called business management—finance, personnel, hangar leasing, logistics, backup boats, and communications. The goal was to win the prize, so I did whatever moved the project toward that goal—and that meant only a little new technology but a lot of project management. □

Sam Durán answered. "Looks beautiful. . . . Let's go for it."

As things settled down, Sam asked Bryan how he was feeling.

"Stabilized out very nicely, no problem." His legs pumping methodically at 80 rpm, Bryan was beginning to realize all the implications of the flight. "So many things that we were doing for the first time. Flying over water, flying with all the boats out there . . . it struck me, what an audacious thing we were doing."

That thought had occurred to everyone on the team at various times, and as a result the *Albatross* carried a number of private good-luck totems. All of them were featherweight, since even a rabbit's foot seems heavy on a human-powered aircraft.

Under the starboard canard tip was the badge of the Kent Gliding Club, where several of the team members had qualified. On the fuselage, in addition to the three big oval Du Pont logos and the airplane's name, there was a small "USA" badge on the right front, the badge of RAF Manston symmetrically opposite it, a 10-pence airmail stamp on the left rear, and on the right side, Bryan's octagonal green "Nothing to Declare" sticker from a day trip to France.

"Control to Albatross. Stay . . . somewhat low, so you don't wear yourself out. Clear." Bryan followed this well-meant advice, dropping down to ten feet, and almost immediately reported difficulty: "Getting some odd turbulence there for a sec."

Indeed, by 15 minutes into the flight, most of the problems that were to dog the rest of it had begun to show up. The first was depth perception. Even though he had an altimeter, Bryan was uneasy when he found that he could look right through the surface of the water without being able to determine where it was. The second was turbulence. "There's a pretty definite interlinking between the water and the air. A smooth sort of bumpiness, but it's bumpy all the time," Bryan explained to the controllers. The third was cockpit ventilation. Despite a Mylar panel with 50 percent reflectivity on the port side of the fuselage, the cabin interior had already started to warm up, and condensed moisture was beginning to fog the windows. Bryan reported that the airflow improved somewhat when he opened the rear adjustable vent. The fourth problem was interference by the flotilla of press boats. They had been given diagrams and a patient explanation showing why it was vital to the safety of the airplane that they stay behind and away from it. For some, the explanation was clearly a waste of time.

At 25 minutes into the flight, Bryan's answers to radio calls were beginning to be punctuated by puffs for breath. "Bryan, what would you estimate it is, powerwise?" he was asked.

"Hard to say, about two eight [0.28 horsepower]."

"Roger. Oh, we're about three miles out now."

They were actually somewhat farther than that, but Bryan sensed that the flight was going slower than planned and that he was beginning to fall behind. He looked over his left shoulder and was disheartened to find that he could still see the cliffs of Dover. The *Albatross* veered 30 degrees off course and he vowed not to look back again.

The flight was now progressing smoothly, almost monotonously, with Bryan turning the propeller at 100 rpm and maintaining an altitude of eight to ten feet. His control motions were smooth and minimal, and he varied from his normal position only to sip some water or adjust his helmet or microphone. Then, at 5:30 the crew asked Bryan for an altitude check and received no answer. "Bryan, this is Sam. How are you feeling?" Still no answer. "Bryan, I'm not getting you at all. Can you nod your head if you can hear me? . . . Roger, okay." It turned out that Bryan could still receive our radio transmissions but couldn't answer. At the time he thought that the perspiration running down his hands had short-circuited the press-to-talk button, but since there was no static or variation, he later concluded that one of the two fine wires to the button must have broken during a control motion.

By 5:52 Bryan had pedaled 9.6 miles and was abeam of the Varne lightship. Half of his water was gone, and the flight was 22 percent behind Paul's original schedule. The flotilla had veered slightly north of the theoretically shortest flight path to avoid a southbound ship track, and the three-to-four-knot easterly wind reported at Cap Gris-Nez was also blowing in mid-Channel. The water, which had been relatively smooth for the beginning of the flight, now began to show ripples of turbulence and a short swell.

At that point Bryan dipped lower, partly because of perception problems and partly to try to find smoother air. The flying effort went up immediately. "Altitude three feet," he was cautioned. Allen realized that he was in a trap, because it takes much more power to pump the plane up to a higher altitude than to maintain it at constant height. "Altitude! Two feet! Bryan, watch your altitude!" Bryan nodded, but couldn't seem to get much above three feet; it was as if the air-water boundary layer was holding the plane down. At that point Paul MacCready's estimate of the flight's chance for success sank from 16 percent to zero.

One hour and seventeen minutes: "Altitude two feet!" again. "Bryan, did you say you were tired?" Even though the media crews couldn't hear the radio transmissions, they sensed that something was wrong. All courtesy went by the board as what Jim Burke now began calling the "press jackals" came roaring in. The transmissions now sounded angry and alarmed: "Altitude three feet . . . Altitude two feet! *Altitude one foot!* . . . Altitude two feet."

The airplane stabilized a little higher, but the swells seemed to lick upward at the *Albatross*'s fuselage, and Bryan's control motions were more extreme. One of the inflatables pulled up close to the plane and Bryan was able to get across to them that his hand was tired. "Okay Bryan, if it gets to the point that you really want to ditch it, or something like that, raise your right hand up over your head and we can move into position." Bryan acknowledged that. "Another thing, what we could do, if you want, we could give you a tow . . ."

"Get It Up, Bryan! Get It Up!"

Bryan meanwhile kept plugging ahead, but it was obvious that he was having trouble. His altitude dropped to one foot repeatedly over the crests. Still, he refused to quit. Paul advised the boat crews that "there's another one and a half hours of flight time required to . . . reach France." Bryan's receiver was noisy, and all he heard was "One and a half . . . to reach France." His heart sank: "One and a half *what?* Hours? How can I do *that?* Never mind the headwinds, just pedal," he told himself, hoping that the message would reach down into his muscles. Pedal and fly.

By 6:25 Paul could encourage Bryan with a milestone: "Control to airplane. We're just about two-thirds of the distance from England . . . to . . . France . . . meaning that it's only about an hour to go. Clear." Bryan had hardly gotten "excellent, great, thank you" out before the *Albatross* dropped to one foot again. "Get it up, Bryan, get it up!" Bryan tried but realized that he was close to exhaustion. "It's no use . . . I'll have to ditch or take a tow from one of the inflatables," he thought. At 6:26 he raised his right hand, the signal to scrub the flight.

The catch ring was under the airplane's fuselage,

For more than four weeks after *Gossamer Albatross* made its first flight over British soil to qualify for the Kremer Cross-Channel Competition, the fragile craft was grounded by Britain's inclement weather. Then on June 11 there was a break, and the next day pilot Bryan Allen, with no over-water experience, took off in a quiet British dawn to fly an unprecedented 35 miles from Kent to Normandy. (*Photo: Don Monroe*)

near the front wheel. Bryan put out a tremendous burst of power and climbed to 15 feet so the nearest inflatable could get underneath the plane, and then began what developed into an inadvertent and frustrating marine ballet between the *Albatross* and the control boat. Although the boat could match the airplane's speed perfectly, matching its lateral motion in the wave chop was almost impossible; the two craft veered sideways past each other again and again. After the third unsuccessful try, the crew suddenly realized that Bryan was trying to avoid the boat intentionally. Over the drone of the outboard they heard Bryan saying ". . . try it up here for a while."

"I had accepted the inevitable—I had to give up. Then when I did climb up to ten or fifteen feet I found the air much smoother and thought, all right! We can keep going!"

At 6:38 Allen's water supply ran out, and a few moments later the crew noticed Bryan tapping the altimeter. They realized that something must be wrong with it; in fact, the batteries were dead. For Bryan, this was one more burden; near the limits of his physical capability, he was learning a lesson that all seaplane pilots know by heart. "I couldn't really judge my altitude from the wave or ripple size. I could look out to the side and estimate my altitude from the angle of the various boats, but that angle would change as they would get closer or farther away. There just wasn't a reliable reference point I could depend on. There's also something slightly hypnotic about flying over water, especially when you're flying close to it. It's a very smooth rolling surface. I would become hypnotized by whatever that was, ripple size or something. Then I would hear 'one foot!' in my earphones."

Allen was now flying without his crucial water supply, without his radio transmitter, and without instruments, in a cockpit that was getting increasingly fogged with moisture despite the vents. "One foot! Altitude one foot. Get it up!" Bryan put out another burst of energy and dragged it up to five feet. At that moment he grimly recalled that one of the Kremer Channel Prize rules was that the altitude of the plane not exceed 50 meters.

It is 6:57. The control boat, quietly, without an exclamation point: "Bryan, I think I can see land." For Bryan it is like a vision of Atlantis. There are still more than three miles to go, and he knows that he is fading rapidly. At two hours and ten minutes, he gets a stab of pain in his right calf, his first cramp. He shifts most of the pedaling load to the left leg, and the cramp in the calf eases, to be replaced by another in the left thigh. He knows from experience that without water and rest they are not going to go away.

Slowly, the coast of France begins to materialize out of the haze.

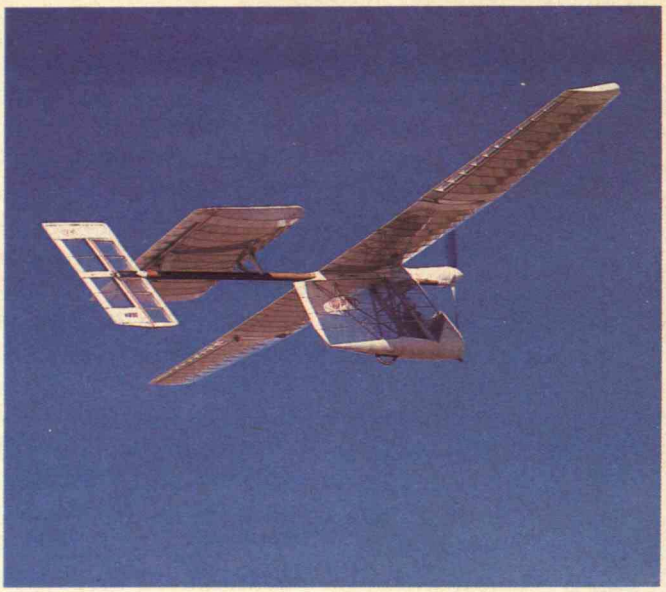
Will there be a landing? Carrying red smoke flares and spotlights, we race down to the beach at the foot of the Cap Gris-Nez cliff. The tide is near neap, and there is a large expanse of wet brown sand exposed. With binoculars, one can just make out the plane, floating like a spectral creature in the white haze. It

The Solar Challenger: London to Paris with Sunlight?

by Morton Grosser

IN January 1979 Paul MacCready sketched the design of a human-powered plane that was a three-quarter-sized version of the *Gossamer Albatross*. It was intended to be a backup craft for the Kremer English Channel Competition that would fly somewhat faster than the *Albatross* and be more airworthy in windy conditions. The team began building it immediately, and because its 72-foot span seemed small beside the *Albatross*'s 94-foot wing, we referred to it as the "sports car." Paul, who had been outvoted on the use of the name once before, insisted on christening it the *Gossamer Penguin*. The *Penguin* was mostly completed in England on the Channel expedition, but it did not have to attempt the crossing successfully completed by its larger cousin and was shipped back to California.

In the spring of 1980, the pedal drive system was removed from the *Penguin* and a small, geared-down electric motor was installed to turn the propeller. With Paul's youngest son, 80-pound Marshall MacCready, as test pilot, the plane made more than 50 flights powered by a nickel-cadmium battery pack. The *Penguin* was then equipped with a pair of king posts that supported a tiltable 45-square-foot panel of photovoltaic solar cells above the wing. The solar panel produced about 450 watts of electric power in direct sunlight and weighed 4 pounds, pushing the weight of the empty aircraft up to 68 pounds.



When she first tested *Solar Challenger*, pilot Janice Brown could fly in only one direction—with the low winter sun falling full on the *Challenger*'s 16,000 solar cells. "But in summer we'll have tons of sun and can fly anywhere," she told writer P. F. Kluge (for *Smithsonian*) early this year. (*Photo: Black Star*)

On May 18 Marshall, then aged 13, made the *Penguin*'s first true solar flight, without assistance from pedals, batteries, or any other form of stored energy. The *Solar Penguin* took off from the ground and flew 100 yards on electrical energy converted directly from sunlight.

Designing the *Solar Challenger*

Much of this research was underwritten by the Du Pont Co., which had supported the *Gossamer Albatross* project. With this backing and encouragement, MacCready began to design a true solar aircraft from scratch. The pilot recruited to fly it is a 32-year-old elementary-school teacher from Bakersfield, Calif., who holds commercial, instrument, and glider pilot ratings. Janice Brown weighs between 95 and 100 pounds, a significant advantage in a program where it was felt that every ounce counted. On August 18, 1980, she flew the *Solar Penguin* more than two miles, the longest solar-powered airplane flight to that time.

Meanwhile, construction of the *Solar Challenger* was begun at Simi Valley, Calif., under the direction of Ray Morgan, an aeronautical engineer who was recruited from the famed Lockheed "Skunk Works." The consultant for the motor and control system is Robert Boucher, familiar to many model airplane builders

seems to be standing still, both to us and to Bryan: "I can make out the French coast, but it seems to come no closer . . ." *"C'mon Bryan, c'mon up, c'mon!! . . . you're mushing!"* "All right! Altitude two . . . Time of flight, two hours and twenty-four minutes."

For the fourth time during the flight Bryan thinks, "Well, this is it. I've done the best I could . . . and I haven't made it." And for the fourth time, some voice inside him answers, "No doggone it, I've still got a little bit left and I'm gonna keep going." The plane's airspeed is now about 12 miles per hour, against a headwind of half that. To everyone, pilot, boats, and beach crew, it is like slow motion, as if the plane were suspended in some translucent gel instead of air. "Only one and a quarter miles to go!" Paul transmits. Privately, he raises his estimate of success from zero to 20 percent. Bryan, listening, thinks, "Less distance than for the original Kremer Prize . . . no headwinds or turbulence then, no thirst, no cramps . . ."

Still he pedaled inexorably closer.

A massive wedge of grey-black stone points seaward, blocking the south end of the beach below Cap Gris-Nez, and these rocks were like the final test in a classic ordeal. At that surreal moment it seemed that they must have been placed there only minutes before, when we weren't looking, to foil the flight at the last moment. Bryan kept drifting to the right, south, below the rocks. "Stick with us, Bryan; don't go to the right. Watch your altitude." "C'mon Bryan, *hang on.*"

For a moment, Bryan considers crashing on the rocks; it would still be land. Then he changes his mind and decides to fly around them, against the wind, and try to save the plane. "One hundred yards. I am flying

as president of Astro Flight, Inc., and a pioneer in electric aircraft propulsion. Ray Morgan's wife Kay and a number of *Gossamer* squadron members from earlier projects have also worked on the *Challenger*.

The *Solar Challenger* looks more conventional than its human-powered predecessors; it is a high-wing tractor monoplane with an enclosed cockpit/fuselage and a tail assembly carried on a tubular boom. Its wingspan is 47 feet, it is 31 feet 5 inches long, and it weighs 195 pounds empty—somewhat heavier than MacCready originally intended. It is stressed for a positive load of five Gs and a negative load of four Gs and has a theoretical flight ceiling of more than 50,000 feet. Its 16,128 Spectrolab silicon cells are rejects from a satellite-cell production line, but even so their market value is between $150,000 and $200,000. They are wired in series rows of 144 cells to yield a potential of 70 volts, and every three rows are cross-wired in parallel to provide alternative current paths in the case of a cell failure. The complete installation produces about 3,000 watts at maximum sea-level insolation and 4,800 watts at 40,000 feet.

At least part of the *Challenger*'s conventional appearance is deceptive. To provide a uniform mounting plane for the solar cells, Peter Lissaman had to design a radical airfoil for the wing and horizontal stabilizer. Most of the upper surface of both components is flat, and the transitional curves at the leading edge had to be computed with great care to produce a craft that would be stable in pitch. (In fact, the *Challenger* is perfectly controllable in pitch and docile in a stall.)

The materials used in the plane are also unconventional. It is built almost entirely of synthetic plastics, including Du Pont Kevlar aramid fiber (used as structural reinforcement as well as in control and bracing lines), Delrin acetal resin, Lucite SAR sheet, Mylar, polyester film, and Nomex aramid paper.

Takeoff on 1,200 Watts

The *Solar Challenger* was rolled out for its first battery-powered trials on November 6, 1980. After several weeks of test flights to iron out bugs and determine trim and handling characteristics, the photovoltaic cell system was connected and the plane made its first solar-powered takeoff at El Mirage airport on November 20. It was soon found that the plane was more efficient than expected; it was able to take off on as little as 1,200 watts of power and made at least one flight carrying a pilot 55 pounds heavier than the design weight.

Despite the unfavorably low sun angle in winter, MacCready decided to have the *Challenger* try an extended test flight. On December 3, 1980, the solar plane took off from Marana Air Park, 30 miles northwest of Tucson, Ariz., on a planned 70-mile course to Stellar Air Park, southwest of Phoenix. The flight was aborted after 6 miles when a propeller pitch-control rod buckled. Janice Brown glided down from an altitude of 1,000 feet to a soft landing in a field near Interstate Route 10. Four days later a second attempt was terminated 15 miles out because of increasing cloud cover.

The current plan calls for the *Challenger* to make a flight of 60 to 100 miles in the southwestern United States this spring and then, possibly with Du Pont sponsorship, to attempt a historic solar flight of more than 200 miles from Paris to London during the summer.

As with the *Gossamer Condor* and *Gossamer Albatross* projects, there is little thought of immediate commercialization for the *Solar Challenger*. It is principally a dramatic demonstration that there is still a wealth of unexplored technology in both aviation and the efficient use of energy. The idea of a passenger-carrying airplane that flies indefinitely as long as it is supplied with sunlight would have seemed preposterous only a few year ago. When aeronautical engineers are told that the *Challenger* is able to take off and carry its pilot to more than 50,000 feet on four solar horsepower, they are usually skeptical and amused. ". . . Four horsepower?" Their expression turns thoughtful when they are reminded that the *Gossamer Albatross* can fly on one-quarter horsepower: "Four horsepower equals 16 Bryan Allens. How many planes do *you* have flying with a 16X safety factor?" □

on reserves I never knew I had."

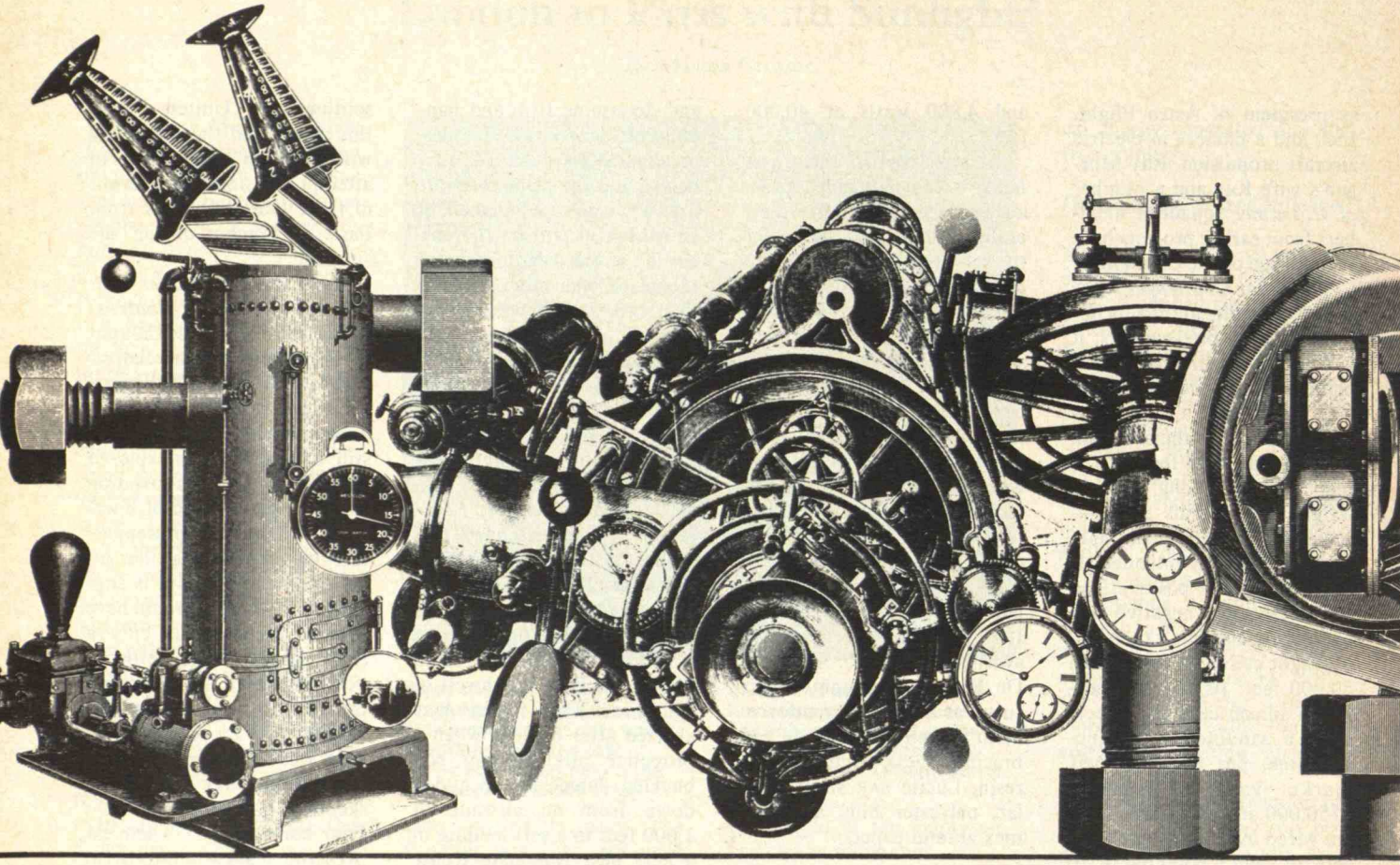
The Albatross suddenly yaws seaward, away from the beach, and Bryan bears down on the controls. The canard tilts all the way over, straining at the antiyaw cords; at 100 feet from the beach Allen has the hideous thought that he has blown it, that he is going to crash into the waves at the last minute instead of making it to land. For an agonizing moment the canard remains tilted over, and then the plane responds. Everything holds. Suddenly it is past the rocks, floating toward us, growing bigger and more familiar every second. A crowd of reporters and spectators is running alongside it; it is strangely quiet, we can hear the sound of their footsteps on the sand. Bryan stops pedaling, and the *Gossamer Albatross* hovers in the air for a few seconds, as if it is loath to land. Then it slowly settles to the ground. It is 7:40, Greenwich mean time. The flight is over.

The flight has taken 2 hours and 49 minutes, exactly 1 minute less than the absolute endurance limit of 170 minutes that Bryan's trainer had predicted five days earlier. The great-circle distance was 22.2583 statute miles, but Paul has calculated that the *Albatross* flew more than 35 miles through the air to cover that distance.

This article, like "Building the *Gossamer Albatross*" (to which it is a sequel) in our April issue, is condensed from *Gossamer Odyssey: The Triumph of Human-Powered Flight* by Morton Grosser, to be published in May by Houghton Mifflin Co. (copyright 1981 by Morton Grosser and Paul MacCready, Jr.).

Morton Grosser studied engineering at M.I.T. (S.B. 1953, S.M. 1954) and worked in biology, electromechanical control systems, and electronic materials before taking his Ph.D. (1961) in the history of science at Stanford and turning to writing and consulting as a career.

TRENDS



Bioresearch

The Incredible Gene Machine

It's almost frightening—a machine that, according to publicity reports, "produces synthetic genes for research and industry" at the touch of a button. Shades of creepy crawlers!

Fortunately, things really aren't that simple. The so-called "gene machines" that have caused such a stir automate just one part of the gene production process. While certainly useful, they will not lead to the assembly-line genetic manipulation their nickname conjures.

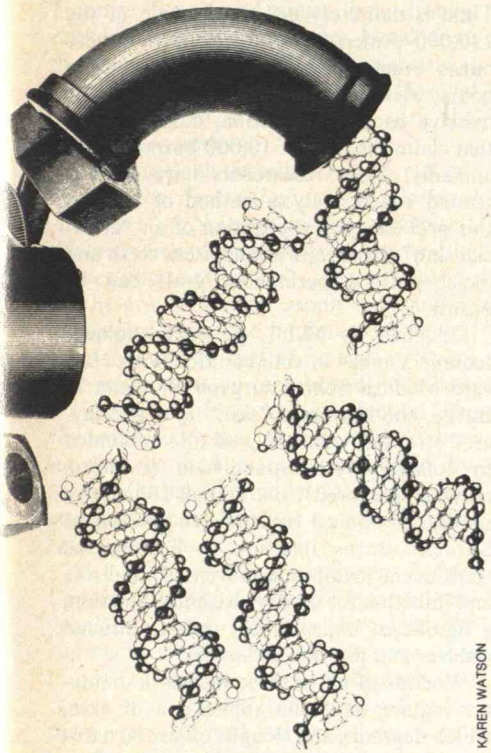
Bio Logicals of Toronto and the Tucson-based firm Vega Biochemicals have each introduced a DNA/RNA synthesizer that should reduce by as much as one-third the time researchers need to link together the basic genetic subunits called "nucleotides." Consisting of a phosphate molecule attached to a sugar on one side and to one of four different chemical "bases" on the other, the pattern of these nucleotides constitutes the genetic code that determines a gene's function and behavior.

The synthesizers work by pumping nucleotides into a column of support material, where they attach to form a single DNA or RNA strand. The operator determines the nucleic acid sequence by punching the desired code into an attached microprocessor. Each machine-induced nucleotide link-up takes 30 to 45 minutes, a fraction of the time needed to produce handmade chains. However, no more than 20 nucleotides can be linked in this manner—far fewer than the several hundred that make up the simplest gene.

"These machines certainly don't produce synthetic genes," explains University of British Columbia biochemist Michael Smith, a pioneer in nucleotide-sequencing research. "But if the manufacturers' claims are true, the machines could serve a very useful function because they perform the most labor-intensive part of the process." However, Professor Smith added that nucleotides must still be purified and verified by hand, which can take up to two weeks.

Reliable, rapid synthesis of sequences 10 to 20 nucleotides long (called "oligonucleotides") is desirable for several reasons. First, whole genes can be made by chemically fusing many oligonucleotides with enzymes. Such genes are injected into microorganisms, where they perform a variety of clinically and experimentally useful functions. Also, oligonucleotides can be used as a probe to fish out natural genes from a mixture. After being labeled with radioactivity, they are incubated with natural DNA, where they attach to a complementary section to form a stable structure that is readily isolated. Finally, they can be incorporated into natural DNA to generate specific mutations that can help researchers study gene function.

Oligonucleotides are currently produced by hand, either by the scientists themselves or by commercial firms that market them at $4,000 to $7,000 apiece. Since the price of the synthesizers is as low as $19,500, it is little wonder that researchers have anxiously awaited their introducton. Another advantage, Professor Smith said, is that the machines will enable scientists to custom-design oligonucleotides to suit their specific research needs. "With 40 billion possible combinations (of bases in oligonucleotides), there is no way a contract research company can supply the market," he said.—*E.R.S.* □



KAREN WATSON

Artificial Cartilage: A Joint Venture

Every year, several hundred thousand Americans suffer joint injuries and diseases that require surgical replacement of the afflicted joint with artificial parts. Unfortunately, orthopedic surgeons have yet to find a good substitute for cartilage, which plays a critical role in joint function. This situation may soon change, however, if current research in artificial cartilage lives up to its promise.

Cartilage, that elastic gristle in our joints, is the body's shock absorber. Translucent and tough, it is deceptively simple in appearance. It must be supple yet strong enough to cushion bones from the stresses of activities as gentle as standing and bending and as jarring as running and jumping. This cushioning property is apparently enhanced by the ability to absorb the watery portion from surrounding joint fluid, leaving behind a viscous lubricant. Moreover, the cartilage is pliant enough to support a film of gellike lubricant even under pressure, allowing joint parts to work smoothly without grinding down.

A successful artificial cartilage would perform all these functions and also not break down or cause adverse reactions in surrounding body tissue. However, until recently, research on joint prostheses has focused on durability and biochemical compatibility rather than biomechanical properties, says Dr. J. Russell Parsons of the biomechanics division at the New Jersey School of Medicine and Dentistry.

For example, in modified hip-joint replacement, the diseased rounded head of the thigh bone is replaced with a stainless-steel ball that fits into the natural "socket." While the steel ball is durable and reasonably inert, it lacks a cushioning cover and almost invariably wears down the natural cartilage lining the hip socket, causing discomfort and pain. The metal further degrades cartilage by blocking access to joint fluid from which it draws nourishment. "You're not only beating but starving the cartilage to death," says Dr. Parsons. Thus, this procedure is satisfactory only for elderly patients who would not expect to develop such problems during the remaining years of their lifetime, or for patients requiring total joint replacement of both "ball" and "socket."

Some years ago, Dr. Robert Pilliar, Dr. Parsons, Dr. Edward Wong (now at Avco Research Laboratory in Everett, Mass.), and their colleagues at the Ontario Research Foundation developed various polyurethanes with properties similar to natural cartilage. Known as thermoplastic elastomers, these substances are able to sponge up joint fluid much as natural cartilage does. They also have the elasticity of cartilage and do not grind away nearby bone or trigger adverse reactions (in animals), making them suitable candidates for implantation in the body. A remaining difficulty, according to Dr. Pilliar, is that the very elasticity of the material makes it prone to wear. This problem is being addressed through improvements both in implant design and the polymer itself.

Dr. Parsons and Dr. Pilliar are currently testing implants of polymer-coated metal balls in canine hips and knees for wear on both the polymer and the cartilage that remains in the joint. If all goes well, clinical trials of polymer-cushioned metal joint prostheses could begin in two years, Dr. Parsons estimates. Eventually, if researchers can develop a material that adheres well to bone, surgery to replace only the damaged cartilage on the surface of the bone could supplant the more drastic total and modified joint-replacement operations.

—*J.K.* □

Skin Tricks

The skin is one of the human body's most expansive and vital organs. This ingeniously constructed barrier provides our best line of defense against disease and dehydration. Yet only when it's ravaged by illness or injury do most of us begin to appreciate the skin's functional flexibility. By then, it's often too late.

Patients with severe wounds or burns, if they survive, often suffer from raised "hypertrophic" scars that are not only disfiguring but, in time, can prove a mighty physical handicap. Stretched over knees or elbows, massive scars can render joints immobile, and severe neck scars can fix a person's head to his or her chest, a deformity often only partially correctable through lengthy plastic surgery.

Scars form because human skin, unlike that of most other mammals, does not migrate from the edges of the damaged area to cover wounds. Instead, the skin constricts, covering the wound with a layer of unspecialized tissue that is incapable of many normal functions. This process can be inhibited by the application of grafts—skin cells removed from noninjured areas and surgically joined to the edges of the wound. But in cases where large areas of the body have been injured and skin is scarce, this can become a problem. Alternatives such as human cadaver and animal skin provide a temporary solution, but both are quickly rejected by the patient as foreign and must be surgically removed and replaced repeatedly until enough of the patient's own skin can be grown for a graft.

Until now, the growth of acceptable living skin was possible only on the patient's body. But recently, cell biologist Eugene Bell and his team at M.I.T. developed a technique whereby skinlike tissue made from a small sample of the patient's cells can be grown in the laboratory—a process which, if proved clinically sound, may someday all but eliminate the scarring problem.

Professor Bell's method consists of two basic steps, one for each of the skin's layers, the epidermis and the dermis. In the first step, fibroblasts (connective tissue) from the patient or test animal are combined with collagen (a protein found in skin, tendon, and bone) in a nutrient medium. There they form a Jell-O-like lattice which, condenses to a fraction of its original volume after several days, bringing the collagen fibers very close together and forming a

This flexible, translucent "skin" (below) is a synthetic membrane designed to prevent dehydration and infection due to burns or other wounds. (Photo: Calvin Campbell)

strong, flexible sheet of tissue that takes the shape of the container in which it was cast. This substance becomes the dermal equivalent.

In the next step, a few epidermal cells are taken from the uppermost layers of the patient's healthy skin, separated from one another with enzymes, and finally sprinkled over the dermal equivalent. There they proliferate, forming first islands and then a sheet of cells. This two-layered "skin" can then be grafted to the damaged area.

"Essentially there is no limit to the size of the skin we can produce," Professor Bell said, adding that his group has already made sheets up to two square meters in area from a single small biopsy.

Animal tests of the technique have proved very promising, according to Paul Ehrlich, a biochemist and director of the wound-healing laboratories at Shriners Burn Institute who is working with Professor Bell. "We've covered as much as 20 percent of a rat's body with the tissue and found that the wound hasn't contracted," Dr. Ehrich said. This means that the skin is "taking" because it actually "splints" the wound, inhibiting the normal pathological process. In addition, tests show that the skin becomes infused with normal blood vessels only three days after the grafting, and that the cells within the graft are viable for as long as a year.

Dr. Ehrlich explained that Professor Bell's product, now under limited clinical trial, would be most useful in elective surgical procedures such as the replacement of scar tissue. Victims of serious skin wounds require immediate body coverage (*see "More Skin Tricks," this page*), and since Professor Bell's laboratory-made tissues require up to six weeks to prepare, they are better suited to nonemergency situations. However, Professor Bell said he might be able to reduce the preparation time significantly by using blood platelets instead of fibroblasts in the first step of his process and eliminating the second step entirely.

"We can use platelets to produce a layer in a matter of hours," he explained. "There are enough platelets in one pint of blood to produce one-quarter of a square meter of material. We don't know for sure yet what the fate of grafts applied without an epidermis would be, but under normal circumstances, this layer grows by itself very rapidly. Clearly, it's better to have both layers present, but in emergency situations, we'd like to be able to skip the second [epidermis-making] step."

Meanwhile, Professor Bell and his team are investigating methods of fabricating other living tissues. By seeding the dermal layer with endothelial cells (which normally line body cavities) for instance, and molding it in a tube, they have already constructed blood vessel replacements.

"Our goal," Professor Bell said, "is to produce tissues that can serve as a substitute for living tissues. The construction in the laboratory of this material is one of the most important challenges of the future."—*E.R.S.* □

More Skin Tricks

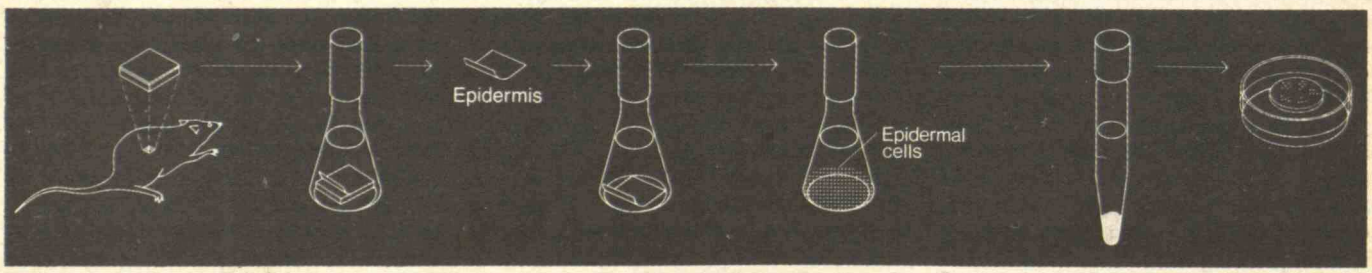
Time is definitely not on the side of the 130,000 Americans afflicted with severe burns every year. If not treated within hours, victims can suffer dehydration or massive bacterial infection, complications that claim the lives of 10,000 burn patients annually. Now, researchers have demonstrated conclusively a method of curbing this problem: the application of an "artificial skin" that keeps wound areas clean and moist until a permanent graft can be grown.

Designed by M.I.T. polymer engineer Ioannis Yannas in collaboration with Harvard Medical School surgeon Dr. John F. Burke, the synthetic "skin" is a two-layered structure consisting of silicon bonded to collagen-glycosaminoglycon (GAG), a polymer prepared from animal connective tissues. In clinical trials on ten patients at Shriners Burns Institute in Boston, the translucent membrane prevented fluid loss and infection for 40 days without rejection, a significant improvement over traditional cadaver and pig skin coverings.

Wounds of up to three inches in diameter require only one application of skin, which degrades and sloughs off as the natural skin regenerates. Larger wounds of up to 60 per cent of the total body require additional treatment because the collagen-GAG layer degrades before the natural skin can reform. Another limitation: the synthetic skin does not prevent scarring.

"Our next objective will be reliable closure of very large wounds with minimal scarring by a single application of the membrane, Professor Yannas said. A modified version of the skin has already proved effective on relatively large wounds in animal studies.—*E.R.S.* □

A small piece of skin is removed from a living animal and the epidermal layer is treated with enzymes to separate the cells, which are then cultured to produce new cells (below). These epidermal cells are then scattered over a layer of dermal equivalent to form a two-layer tissue similar to human skin.



Tumor Torture

Tumors, like the infamous Transylvanian vampire, survive by sapping blood from their unwitting "hosts." Now, scientists at M.I.T. and Boston's Children's Hospital are on the trail of a means to curb this deadly phenomenon.

Their method, described in a recent volume of the *Proceedings of the National Academy of Science*, involves inhibiting the migration of blood vessels from healthy tissues into the tumor site, thereby cutting off the growth's blood supply and snuffing its development. The inhibitor is a natural substance (an extract of animal cartilage) that initial tests on rabbits and mice have shown to be safe as well as effective. The researchers say that such substances may someday be used to treat a myriad of diseases resulting from abnormal blood-vessel growth, such as arthritis, various skin diseases, and cancer.

M.I.T. biochemical engineer Robert Langer, who with Children's Hospital surgeon Dr. Judah Folkman developed the approach, explained in an interview that tumors release an organic substance that causes blood vessels from surrounding tissue to grow toward and into them. Cartilage is itself totally devoid of blood vessels and, it was discovered several years ago, contains a substance that actually curtails blood-vessel growth. The problem, then, was to isolate the fraction of cartilage with this substance and keep enough of it in an experimental animal's bloodstream to prevent vascular development in tumors.

"We chose the cornea as the tumor site because normally corneas do not contain blood vessels," Langer explained. "That way, there was no background problem—the blood vessels that grew due to the tumor were readily quantifiable."

Langer found that the extract quickly dissipated if injected directly into the bloodstream. Therefore, he developed a method of encapsulating the substance in a polymer that allowed it to release slowly over a period of 30 days, long enough for the blood-vessel-inhibiting factor to take effect. Examination showed that vessel growth in eye tumors "essentially stopped" in animals treated with the inhibitor, while tumors in untreated control animals continued to vascularize and grow normally.

"The major focus now is to purify the extract completely, to get it down to a single molecule that has the same inhibiting effect," Langer said. Of the thirty fractions of veal cartilage tested, only one reduced vascularization without causing excessive irritation to the animal. But, Langer explained, exactly which chemicals inhibit blood-vessel migration is still unknown.

Langer said it took a "gigantic" amount of cartilage—500 grams—to get a single milligram of the inhibitor. Since veal cartilage is relatively expensive, he and his team are testing alternative sources—including sharks, which have entirely cartilaginous skeletons.

"The most important value of our work so far is that it proves that control of tumor growth is possible through the inhibition of vascularization," Langer said. "We've developed a good quantitative model through which other inhibitors can be studied. It is possible that other inhibitors will be found or synthesized that will be even more potent."—*E.R.S.* □

How Not to Cut Health Care Costs

Federal regulations aimed at limiting health care costs by requiring hospitals to justify the need for new facilities represent "big guns aimed at small targets." Such "certificate-of-need" programs can play at best only a minor role in containing the rising cost of U.S. medical care, say Dr. William B. Schwartz, professor of medicine at Tufts University School of Medicine, and Paul L. Joskow, professor of economics at M.I.T.

The savings produced by such regulations are "probably worth the effort," but the overall effects are disappointing, they write in *The New England Journal of Medicine*. Significant reductions in medical costs cannot come from mandated planning programs; they can come only through changes in the quantity, quality, and basic patterns of U.S. health care, Professors Schwartz and Joskow conclude.

When the U.S. Department of Health and Human Services set up its certificate-of-need program, it estimated that reducing the number of new computerized tomographic (CAT) scanners, facilities for open-heart surgery and radiation therapy, and hospital beds could save $10 billion a year. Professor Schwartz and Joskow put the annual potential savings at only about $1 billion. And some of that would be wiped out by the costs of moving patients from one medical facility to another in search of beds and "banned" equipment and by the expense of administrating the certificate-of-need program.

This "relatively small effect should surprise no one," said Professors Schwartz and Joskow, because few health care facilities are operating below minimum caseloads.

In their detailed analysis, Professors Schwartz and Joskow said $85 million might be saved on CAT scanners, $115 million on radiation therapy, $50 million on open-heart surgery facilities, and $800 million on new hospital construction each year under a certificate-of-need program. But they pointed out that this $1 billion total savings is less than 2 percent of the $58 billion annually expended by short-term general hospitals in the United States.

Meanwhile, in 1978 the HRA spent $160 million on the "complex apparatus for planning and regulation," and the states could well have spent half again that much. And hospital costs of preparing and defending applications for new facilities may have been as great as the agency's.

"Most discussions of cost control assume that there is a huge 'free lunch' being served in the hospital sector," say Professors Schwartz and Joskow. But they think not: "Perhaps there is a snack here and there, but certainly no banquet."—*J.M.* □

Automation

New Smarts on the Production Line

Visions of truly "smart" machines are the stuff of productivity dreams. How close are those dreams to reality?

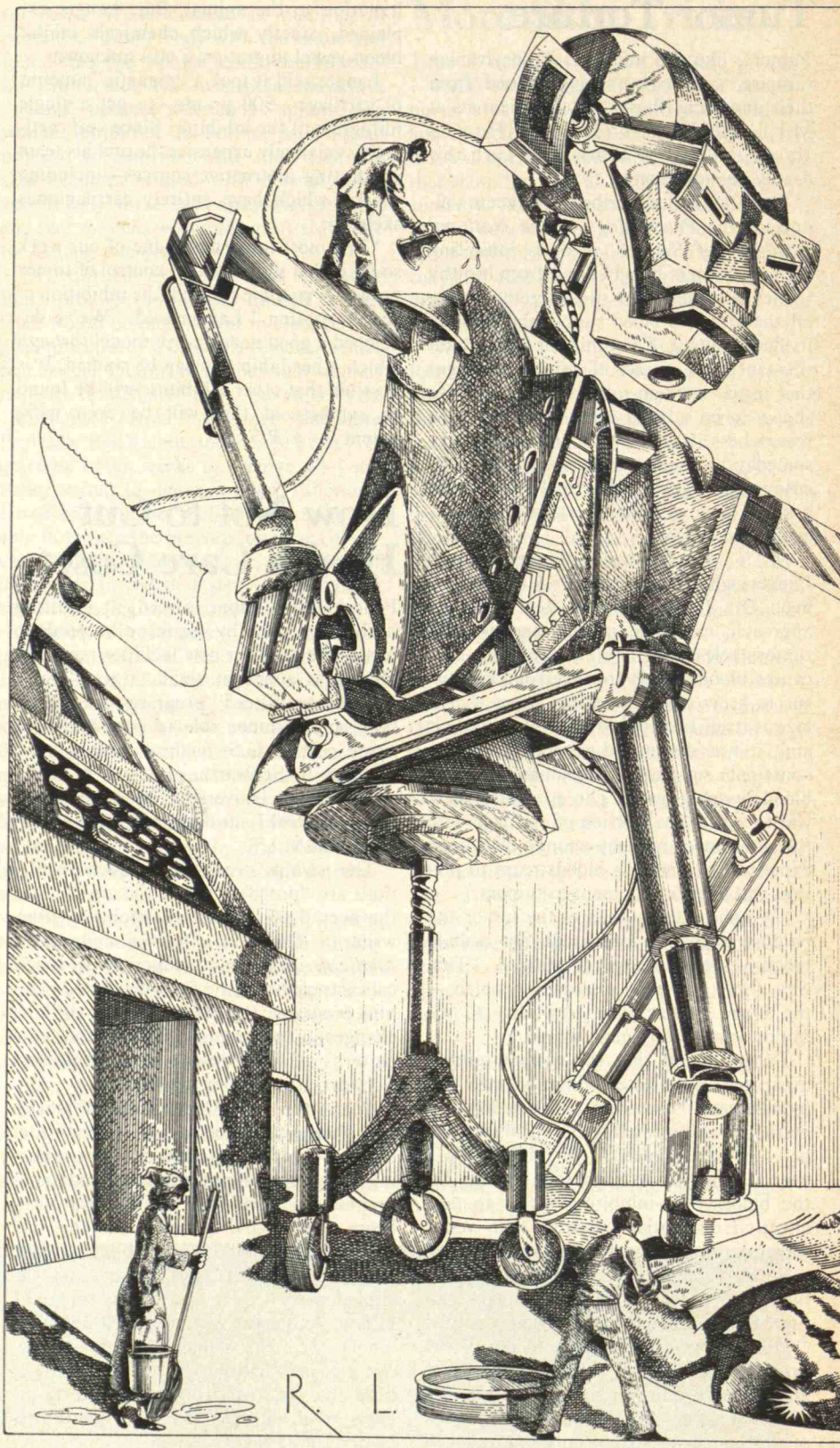
Until recently, machines have been able to respond only to rigid, preprogrammed guidelines. But the development of "very large scale integration" technology—microprocessors—has made it feasible to give machines a practical sort of artificial intelligence. The resulting smart machines control themselves to do many different tasks under a variety of real-world conditions.

The need to develop sophisticated control algorithms—the mathematical bases, in this case for programming—that make the magic possible was characterized graphically at a symposium on automation research held at M.I.T.: "A [sheet-metal] brake press looks massive next to your meager little body, but at rated load, it turns into rubber and steel sheet turns into Jell-O." Continued David C. Gossard, associate professor of mechanical engineering at M.I.T., only remarkably talented machines can accommodate unforeseeable variations in materials, and most of those are prototypes in research laboratories. All can monitor their own performance (some can monitor others as well) and make necessary control changes on the fly.

The fundamental challenge in designing such machines is to find a reliable diagnostic "handle" for the machine to measure and react to. Machines with such "adaptive" or "closed-loop control" can automatically do jobs that are "too complex for reliable prediction," with practically no waste or error, according to David E. Hardt, assistant professor of mechanical engineering at M.I.T.

The hitch? "We can't measure what it is we want to control directly," he explained to the conference.

Take welding, for example. A good welder can tell from the sound of a welding arc if the weld is good, Thomas W. Eagar, associate professor of materials science at M.I.T., told the symposium. Sound probably wouldn't be a good characteristic for an automated welding machine to use as the basis for adaptive control, but the voltage of the welding arc is. Such a voltage-monitoring welding machine now stands in Professor Eagar's laboratory. Once it has made a few inches of preliminary weld and adjusts to a job, it produces uniformly



ROGER LEV

high-quality work.

A microprocessor linked with an automatic press brake in Professor Gossard's laboratory controls the motion of the machine's punch. As the punch penetrates the metal work piece, the microprocessor calculates the point of contact as a function of the force expended during the penetration, and tells the machine precisely when to reverse its motion for an ideal result. The machine treats every work piece as a brand new one, and completes each cycle in only 0.3 seconds—with a twofold improvement in quality over humans and essentially no waste. Professor Gossard's feeling about the value of adaptive control: "Any direct measurement beats prediction."

Adaptive control can handily overcome the slop and strain in machine components. For example, the heavy, beamlike arms of large manipulator robots bend slightly as they move and are very difficult to control precisely. Professor Hardt described hauntingly humanlike arrangements of microprocessor-equipped "arms" and "fingers" and a simple but ingenious noncomputerized "wrist" that compensates for a panoply of possibilities. Such innovations are needed to make automatic control possible in real machines, which are made of elastic materials and operate on parts that can stick and jam.

Regardless of their romantic lure, dextrous, intelligent machines are not for all types and rates of production. Their strength is in performing complex operations involving assembly and disassembly on a small to moderate scale, according to Stanley B. Gershwin of the M.I.T. Laboratory for Information Decision Systems. Simple, repetitive, high-volume tasks are best done by conventional "dedicated," "nonintelligent" machinery.

Unfortunately, managing and controlling *combinations* of automatic machines isn't nearly so easy as it sounds. Machines are unreliable, and the choices for which they must be programmed increase rapidly as their numbers grow. A well-designed network of machines and buffers (storage areas) can adjust to variations in the performance of its constituent machines and to the "blocking" and "starving" of unfinished materials along the production line. Daniel E. Whitney of the Charles Stark Draper Laboratory and the Department of Mechanical Engineering at M.I.T. described such experimental networks that automatically assemble automobile alternators and rear axles.

But beware the siren song of overautomation, warned Berthold K.P. Horn, professor of electrical engineering and computer science at M.I.T. He raised to criticism a scenario in which a complex production robot is surrounded by a few humans who "sweep the floor and orient the parts." Said Professor Horn: "That is not a good use of labor."—*L.A.P.* ☐

Who Pays the Hidden Costs?

Machines do all the monotonous jobs in Alvin Toffler's *The Third Wave*, leaving people with "enough leisure to follow interesting pursuits outside [their work] . . . and [unlimited] opportunities for personal creativity." But does the new wave of automation—a key feature of "reindustrialization"—promise such a paradise?

Harley Shaiken, research fellow at M.I.T. and frequent consultant to the United Auto Workers, thinks not. He told *Technology Review* that too often the issue of automation is falsely posed as a question of being for or against new technologies, when the real question should focus on responsibility for the social consequences, such as retraining and relocation of displaced labor.

Robert M. Solow, professor of economics at M.I.T., has a different view of automation. The fear of technological unemployment is "one of the great uniformities of intellectual history," he told the *Review*. The potential effects of automation have always been overestimated, and the new wave of technology is unlikely to produce a huge displacement of labor. Classical economics suggests that automation will bring greater productivity and eventually new markets—including the rapidly expanding market for robots—that will spur the economy and employment. For example, General Motors Corp. plans to "hire" some 5,000 robots by 1985 and 13,000 by 1990, but Professor Solow is confident that displaced workers will find jobs producing goods for the new markets.

However, Shaiken urged that today's automation not be compared with the world's first two waves of mechanization—the Industrial Revolution of the nineteenth century and the postwar boom of the 1940s. During the 1800s, demand for industrial labor in the cities was strong enough to draw rural workers displaced from newly mechanized farms. During the 1940s, the growing white-collar and service sectors absorbed the displaced labor. But the invisible hand that on these occasions moved people from one sector to another is arthritic now, perhaps paralyzed, and the social costs of today's new technology may be much higher, warned Mr. Shaiken in a debate at Harvard's Kennedy School:

☐ Today's automation will replace workers in manufacturing, offices, and the service sector simultaneously. Because there is no assurance that enough jobs will be created in growing sectors such as health care, insurance, services, and banking "there is the likelihood of both serious displacement and structural unemployment."

☐ Blue-collar workers displaced by the robots may not be qualified for the new white-collar jobs that will develop.

☐ The new jobs may require relocation as well as retraining, and could precipitate large-scale, regional disruptions.

☐ The nature of work itself may change significantly. If technology "devalues skill and increases control over work forces," says Mr. Shaiken, we may pay for economic growth with less satisfying and more degrading work. Systems that reduce creative input "minimize the real value of human workers, in the long run a hidden productivity cost."

Who will bear the burden of these social costs —industry, government, communities, or individual workers? Dr. Solow offers two solutions. Employers could guarantee long-term employment and retraining, as do certain Japanese companies, but that might change the role of business in employees' lives and reduce its flexibility in responding to competition. Or government could accept responsibility as it did under the Trade Readjustment Assistance Act, designed to provide relief to workers who lost their jobs owing to competition from imports.

But Mr. Shaiken points out that moving auto workers from Detroit to Houston is "not just moving a series of materials or factors of production, nor even just moving individuals. It is disrupting communities and community life in possibly a permanent and potentially disastrous way." Although cities absorbed labor after the first two waves of mechanization, urban problems during the past few decades suggest that the changes were not without costs to be paid years later.

Technology involves a "series of choices governed by social as well as technological and economic considerations," says Mr. Shaiken. He stresses that assessments of technology must include the people who make it work: "To have a democratic society, we need a technology that is developed in a democratic direction and by democratic processes."—*Barbara Goldoftas* ☐

Tooling Up for the 1980s

The beginnings of reindustrialization are everywhere around us, says Edward E. David, Jr., president of Exxon Research and Engineering Co. At the American Association of Engineering Societies in Houston last fall he rattled off some examples: a major new synfuels industry, the growing influence of microelectronics at all levels of technology, a new communication-computing industry for public use, robotics in production technology, new "smart" weapons and sophisticated instruments on the ground and in space, and genetic engineering.

But Dr. David isn't sure that it will all happen, because "the balance between creating new technology and applying it seems out of whack." We still fail to understand that the real obstacle to technical progress in the U.S. is a lack of attention to engineering itself, not to basic or even applied science. Research and development cannot adequately substitute for project engineering. There are three parts to that job:

☐ Build excellence into engineering design. We must "recommit ourselves" to that goal, Dr. David said.

☐ Promote "more productive relationships among the triad of institutions where nearly all engineers work—government, industry, and universities. . . . There are proliferating fears of risk taking and unfamiliar technology," he said, reinforced "by volatile government regulation and by loss of confidence in our institutions. And when we are not fearful we are contentious; it is a fact," said Dr. David, "that the U.S. has 4 times as many lawyers per capita as West Germany, 20 times as many as Japan."

☐ Improve communication between engineers and society at large, particularly with government. As engineers, said Dr. David, "we think of ourselves as men and women of things, not words. But we must recognize that our impact upon society in the 1980s will be conditioned as much by our influence on the invisible structures of human thought as on the visible structures of engineering handiwork."

Dr. David detects "a renewed sense of reality" in the United States after an era when society was "easy prey for all kinds of glib proposals involving pseudo-logic, pseudo-science, and pseudo-engineering." To consolidate this new realism, engineers must "see to it that society comes to terms with the true complexity of the problems it faces."—*J.M.* ☐

VAUGHN MCGRATH

Macroengineering

Engineering the Rise of the Macro

This may be the frugal age of environmentalism, risk assessment, appropriate technology, double-digit inflation, and even antitechnology. But macroenginering projects, the billion-dollar engineering programs at the limits of people's ability to manage and build (and perhaps even conceive), are alive and well. Macroengineering is a "recession-proof" discipline, exulted one delegate to what may have been the first symposium on the subject, at M.I.T. Today the most obvious manifestations of macroengineering are in the OPEC countries, where large-scale engineering is encouraged by prodigious wealth, resources, and needs. But John E. Forbes, former deputy director general of UNESCO, sees a far wider opportunity in nine areas of worldwide macroengineering:

☐ Transportation, including a long-sought tunnel connecting Britain and France and a bridge spanning the Strait of Gibraltar.

☐ Natural resources. After intensive surveys, the World Bank now has identified a series of coal, lignite, and mineral projects for which it is ready to lend money. Many will require development of roads, ports, and other infrastructures, themselves macroengineering projects.

☐ Rural and land development—dams, irrigation projects, and hydroelectric facilities.

☐ Environmental development—reforestation and the regeneration of farmlands that have lost their productivity. (These, said Mr. Davidson, will be "the major tasks of the next century.")

☐ Urban development, needed in countless cities throughout the world.

☐ Transmigration projects, proposed to move large numbers of people from inadequate to more acceptable environments.

☐ Preservation, such as the effort to save Egyptian antiquities from the waters of the Aswan Dam.

☐ Ocean engineering—controlling the seas and utilizing their abundant resources.

☐ Space utilization, including communications and platforms for research, manufacturing, and perhaps colonization.

If Professor Jay W. Forrester of M.I.T. correctly reads his models of economic change, the "great day" for many of these macroengineering works may be 15 years away, when we are on the upswing of a "long wave" of repeating shortages and surpluses of capital stock. That mechanism has "to a considerable extent fueled the great waves of technological change," Professor Forrester told the symposium; "If there were no depressions, there would be no macroengineering."

Can macroengineering become a bona fide discipline?

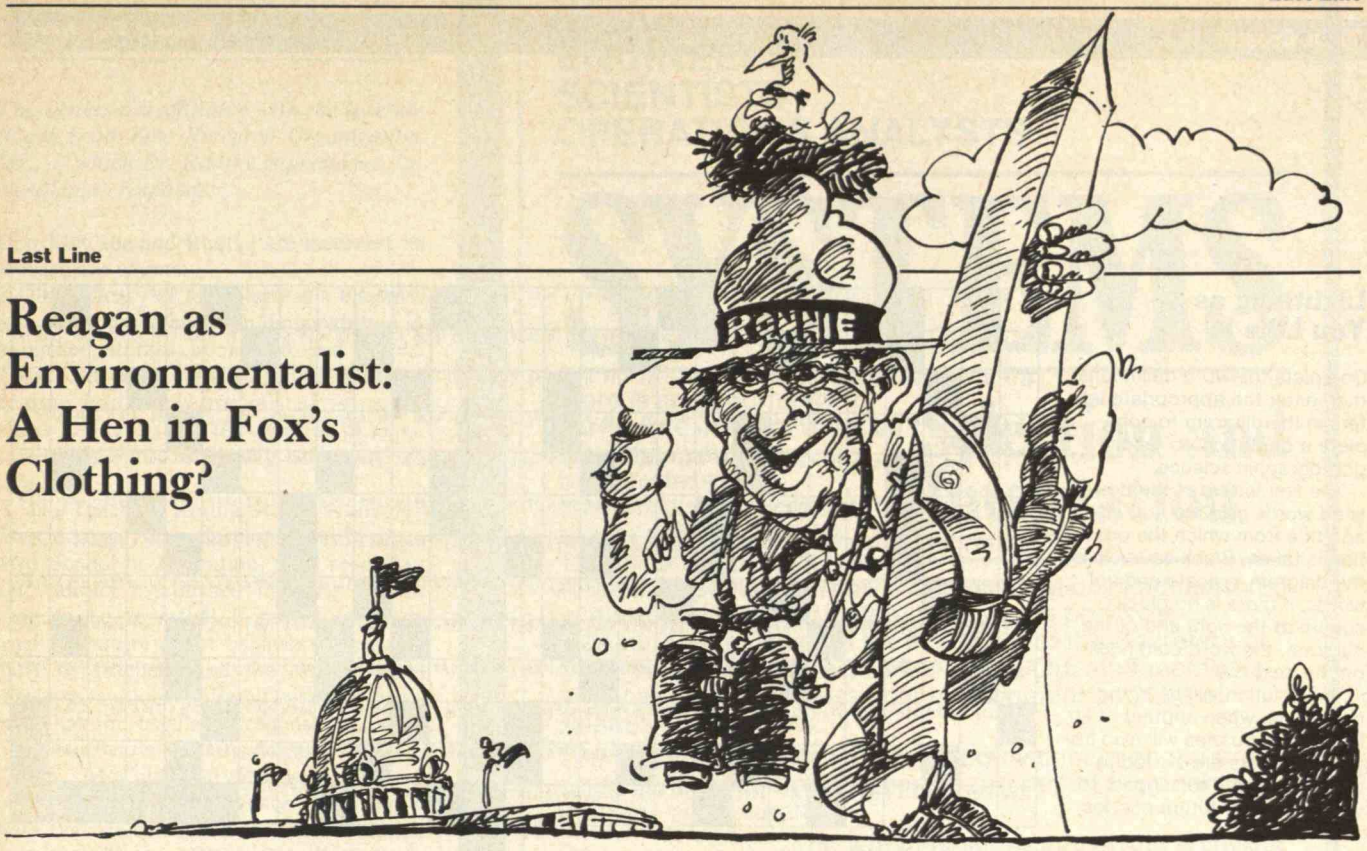
Frank P. Davidson of M.I.T., who convened the symposium, foresees that "an integrated, interdisciplinary approach to large-scale projects, programs, and systems could provide policy guidance on a whole range of issues of deep concern to both the private and public sectors." He expressed his confidence that "a workable general theory of macroengineering, meshing traditional constitutional values with the burgeoning capabilities of technology, will be of high utility."

One development toward macroengineering as a discipline was offered by C. Lawrence Meador of M.I.T.'s Macroengineering Research Group. He described the need to carefully weigh and coordinate the myriad decisions pertinent to the social impacts, resource needs and technological demands of extremely large engineering projects.

Clearly, the conferees hoped that their discipline would be ready by the time Professor Forrester's models predict its indispensability.—*J.M.* ☐

Last Line

Reagan as Environmentalist: A Hen in Fox's Clothing?



When Ronald Reagan was governor of California, the quickest way to turn him red and start him shaking, recalls Russell Peterson (former governor of Delaware and currently president of the National Audubon Society), was to mention the word "environment."

Certainly any campaigning candidate who'd overlook air pollution from power plants and cars and instead indict Mt. St. Helens and trees was not out to impress the voters with his concern for environmental issues. But what was quaint and amusing during Reagan's run for the presidency appears to be a serious threat, now that he's in office, to the antipollution strategies of past administrations. With a secretary of the interior far more devoted to the "multiple-use" development of natural resources than to their conservation, an administrator-designate of the Environmental Protection Agency (EPA) with virtually no experience in either administration or the environment, and a drastic reduction in staff and capabilities of the President's Council on Environmental Quality (CEQ), environmentalists have sufficient reason to believe that their worst fears will soon be coming to pass.

"What we're seeing is a systematic effort to neutralize the regulatory agencies and dismantle the environmental gains of the last ten years," Robert H. Harris (one of three Carter-appointed and recently retired members of the CEQ) told *Technology Review*. "It all makes sense," he says, "if you think environmental regulation is too expensive, that its costs have far exceeded its benefits, that it's a primary cause of unemployment and a major factor in America's slipping rates of productivity and innovation, and that the EPA has been controlled or unduly influenced by environmental extremists."

But that is not what the majority of Americans believe, according to surveys throughout the past decade by virtually all the major polling organizations. The most recent involved 1,576 respondents and was commissioned by four federal agencies (the CEQ, the EPA, the Department of Energy, and the Department of Agriculture) and conducted by Resources for the Future (a nonprofit research institute) with the assistance of the Roper Organization and Cantril Research, Inc. They found "a solid majority (62 percent) who said they sympathize with the environmental movement; an even larger majority (73 percent) said the term 'environmentalist' applied to them 'definitely' or 'somewhat'; and an overwhelming majority (83 percent) wants government to screen new chemicals for safety before they are allowed on the market, even if doing so might keep potentially useful chemicals away from the public."

"Only 4 percent consider themselves unsympathetic to the environmental movement," said Gus Speth (CEQ chairperson) in announcing the results of the study last fall. He said that although pollution problems "are no longer viewed as crisis issues by most Americans, whose top concerns now are inflation and the energy shortage, the U.S., by and large, is a nation willing to pay the price for environmental quality."

Dr. Harris is concerned that despite the implications of such polls, the EPA's already meager regulatory powers will be compromised. But Valerie Bennett, a political scientist with Energy Resources Co. in Cambridge, Mass., and a long-time consultant to EPA and other federal agencies, foresees improvement in the elimination of at least some regulations, such as those intending to preserve air quality where it is currently good. These turned out to be "hoops to jump through," with value neither to the environment nor the economy.

According to Dr. Bennett, "The EPA will be an exciting place under Reagan. Instead of shoving pollution from one medium to another, the emphasis will be 'multi-media' and global. After-the-fact and unproductive 'technical fixes,' such as pollution-treatment devices tacked on to inherently polluting processes, will no longer suffice." Instead, she predicts that cost-benefit analysis, and other quantitative methods, will be used to stress creative market solutions.

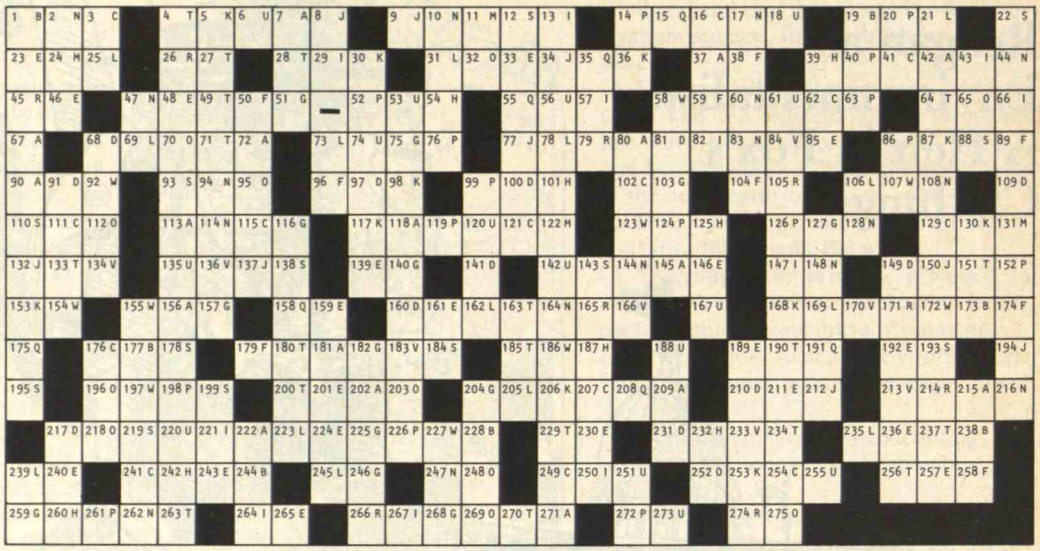
But Dr. Harris is not so confident that the relaxation of environmental regulation in favor of private-enterprise initiatives will be a step in the right direction. "I've never seen a company, even among the most enlightened, that considered environmental affairs to be anything more than a public-relations problem. And although it makes good sense to leave many kinds of decisions in private rather than governmental hands, environmental problems are the best reason I know for regulatory intervention in the marketplace."—*S.J.M.* □

Lightning as You Like It

Complete the word definitions; then enter the appropriate letters in the diagram to complete a quotation on recent photographic science.

The first letters of the defined words give the author and title from which the quotation is taken. Black squares in the diagram indicate ends of words; if there is no black square at the right end of the diagram, the word continues on the next line.

The solution will be in the next issue, when another of Mr. Forsberg's puzzles will also appear. Readers are invited to comment—and to suggest favorite texts for future puzzles.



A Russian satirist/novelist 1826-99 *The Golovlyovs* (comp)
7 118 215 67 113 90 202 222 156
42 145 80 72 271 181 37 209

B Whence Young Lochinvar is come out (2 words)
1 177 238 19 244 228 173

C Part of Beethoven's Opus 84 (2 words)
254 41 241 16 129 176 249 207 111
121 102 115 62 3

D Kansas creek, scene of massacre. 1856
149 109 81 68 100 160 141 210 97
231 217 91

E Nobel laureate in Physics, 1913 (full name)
161 236 48 243 265 146 23 224 159
201 33 139 257 85 211 240 46
192 230 189

F Lighthouse featured in a folksong
174 104 258 96 179 50 89 38 59

G Field of Nyquist, Bode, and Guillemin (2 words)
268 225 140 259 182 116 157 246 204
127 103 75 51

H Locomotive and caboose alone; freeloader
187 39 232 101 260 54 242 125

I Fictional (?) creation of Edward Lear (3 words)
267 13 221 82 57 29 250 147 264
66 43

J Entranceway: portico
137 150 9 8 194 34 132 77 212

K 5286-meter dormant volcano in Mexico
168 30 36 206 117 5 253 98 130
87 153

L One item in John Masefield's "Cargoes" (3 words)
21 73 205 162 239 106 69 245 31
223 235 78 169 25

M Food for computers
24 122 131 11

N An indirect printing process (2 words)
148 47 60 108 44 128 94 83 17
2 114 247 262 144 10 164 216

O English Government during the Interregnum. 1649-1660
196 275 203 218 248 112 252 70 32
95 269 65

P Metaphysical theory according to which mental processes are byproducts of physical ones
63 14 272 152 99 261 124 52 198
76 226 20 126 40 86 119

Q Its capital is Porto-Novo
175 55 15 35 158 208 191

R Intermediary; third party (comp)
79 105 26 45 274 266 171 165 214

S Order of Mayflies
184 219 143 178 22 199 12 193 110
195 138 88 93

T "Miss——" (Ogden Nash. "Private Dining Room") (3 words)
237 190 200 49 263 133 180 27 229
151 71 234 163 256 4 28 270
64 185

U Recent disaster film (2 words)
273 18 142 120 220 167 56 135 188
53 251 74 6 255 61

V North American Warbler, *Seiurus Aurocapillus*
213 170 134 84 183 136 166 233

W Builders of Petra, 4th century B. C.
172 197 58 155 227 107 154 123 186
92

Letters/Continued from page 4

The writers are affiliated with the International Lead Zinc Research Organization, Inc., of which Dr. Radtke is president. Dr. Needleman responds:

Drs. McCabe and Radtke are incorrect on at least five counts:

☐ The efficacy of tooth lead as a classifier of past exposure has been demonstrated in published studies by myself and others. There can be essentially no question that dentine lead levels are related to earlier blood lead levels and the duration of exposure. This is precisely why we chose this assay.

☐ The Teachers' Rating Scale was adapted from a larger scale developed at the Harvard School of Education, with reliability and validity established in other studies soon to be reported. Common language used to inquire about behaviors measured daily by teachers, and the regular dose-response relationship found with lead, indicate that the teachers' responses are anything but "variable and arbitrary."

☐ Drs. McCabe and Radtke appear to have overlooked the sentence in which we state that we controlled for socioeconomic status and parental IQ by analysis of covariance. This is a conventional technique discussed in numerous intermediate biostatistical texts.

☐ No data in our study permit Drs. McCabe and Radtke to infer that parents of high-lead subjects were poorer care givers. To the contrary, when we compared parents of high and low subjects on an attitude scale that measured expectancy, attitude toward school, and quality of care giving, no difference was found.

☐ Nowhere in the brief article did I claim "definitive" status for our study. My colleagues and I set out to directly address the flaws found in other studies of low-level exposure in children, and I believe, to a considerable extent, we have been successful.

Solution to May/June Crostic

The first spark photo was made by Fox Talbot . . . in eighteen fifty-one, and before that there were lightning strokes. All you had to do was open your camera and let nature give it a whack. So people ask me whether I invented the strobe and I say, no, it came from heaven. The only improvements we made were to make it go off when and where we wanted it to.

Stephen Davis, "'Doc' Edgerton" *OMNI* magazine, September 1979

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